

AMD RYZEN REVIEWED: THE UNDERDOG HAS RETURNED!

200

April 2017
Issue 440

YOUR EXPERT

GUIDE TO TODAY'S TECH



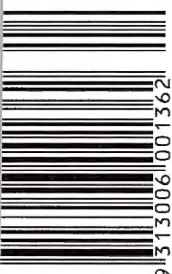
AMD IS BACK IN THE HIGH-END CPU GAME, WITH THREE NEW 8-CORE CPUs THAT ARE READY TO TACKLE INTEL'S FINEST

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FIRST MESH-NETWORKING ROUTERS

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Should we reject the Facebook future?

APC's editor wonders if the high-tech future
that Silicon Valley dreams of
is worth the trade-offs.

Tech billionaires looking to change the world has become a theme in today's Silicon Valley culture; Telsa's Elon Musk wants to solve South Australia's (and the rest of the world's) power problems and Amazon's Jeff Bezos and Musk are facing off with their pet space-travel projects. Google even has a division dedicated to 'moonshots' – big ideas that probably won't pay off, but could be huge if they did. And as Western governments' appetites (and budgets) for forward-looking projects have shrunk, it's mildly reassuring that someone has taken up the mantle of imagining a brighter future.

There's a trade-off in shifting this power away from governments and onto corporations, however. That's something that recently hit home for me when Mark Zuckerberg, CEO of Facebook, published a 6,000-word manifesto titled 'Building Global Community', covering a wide range of topics about where he sees the social networking going next. The one theme that runs through it all, though, is that it hands more power over to Facebook. Zuckerberg envisions a world where Facebook is the solution to many of our modern ills, be that crushing fake news, encouraging people to get together in the real world or even bringing about direct democracies, where citizens can vote on important political issues via (of course) Facebook.

Coming from a company that's repeatedly shown a disregard for its users, that's terrifying. Over its 12-year existence, Facebook's repeatedly been flayed by the public and media about its handling of users' privacy, it runs tests on some users including deliberately creating a buggy, crashing version of its Android app to see how many times people would open it before they gave up, and its 2013 attempt to introduce a free internet scheme in India was rejected once the country figured out it could actually help to give the social giant an unfair or even monopolistic hold on the local market.

There's a reason that, in the West, we've entrusted our governments with holding the kind of powers that Zuckerberg seemingly wants to wield via Facebook – governments can at least be held to account.

If Zuckerberg really wants to change the world, he should follow Bill Gates' example – hand the reigns of running Facebook over and devote himself solely to philanthropy. Because, honestly, it's hard to be truly altruistic when you're always looking out for numero uno first.



DAN GARDINER
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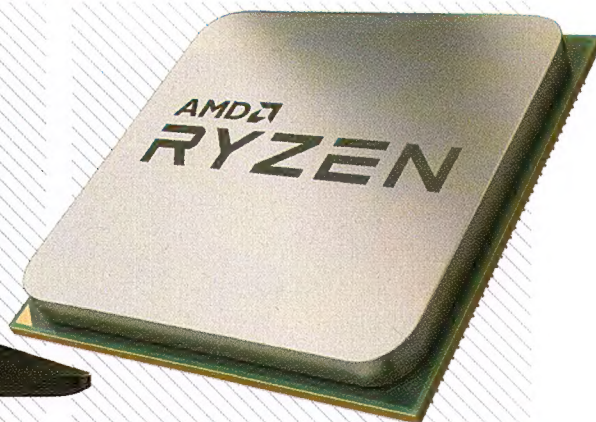
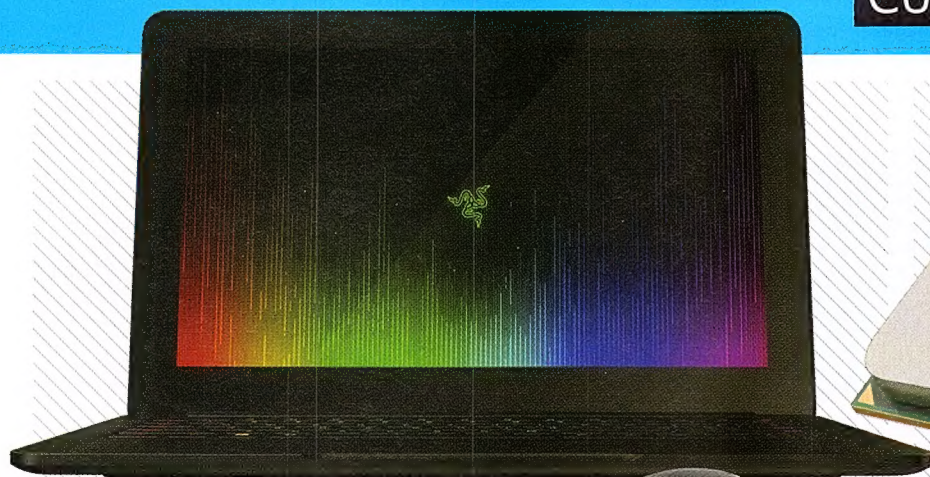
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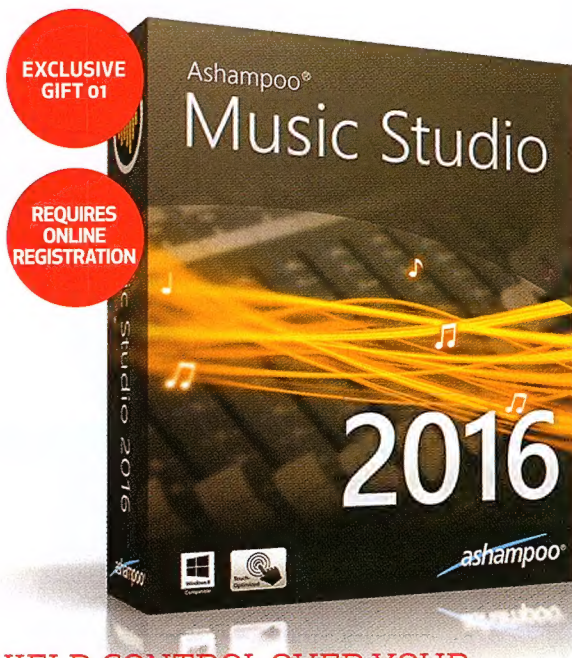
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ISSUE 440, APRIL 2017

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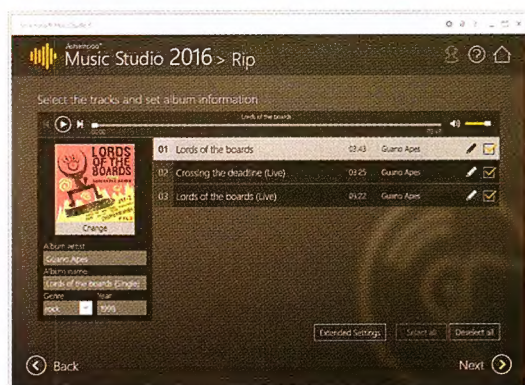


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EXPERT REVIEWED

the lab
» LATEST REVIEWS

AMD RYZEN

apc HOT PRODUCT

AMD Ryzen 7 1800X
The Red Wedding

It's hard to deny how much hype the Ryzen has generated, with many hoping that it would shake up the market, and unseat Intel from its perch of pride. So has it met our expectations? And is it worthy of the hype?

The Ryzen 7 1800X is an octa-core, 16-thread, 14nm behemoth of a processor. Each core sports 64KB of L1 cache, followed by 512KB of L2 cache, and 8MB of L3 cache shared between each set of four cores, giving each R7 series chip a combined total of 16MB of L3. Instead of allocating 2MB to each core, the cache is shared across each set of four.

So what's the difference between all the 7 series chips? It mostly comes down to two things: clock speeds and TDP. At the very top of the ladder is the Ryzen 7 1700, with a clock speed of 3.0GHz at stock, boosting to 3.7GHz, and a 65W TDP. If overlocking isn't your jam, this is perfect. Next is the 1700X, with a 3.4GHz stock clock speed, and a 65W TDP.

Now the bit you've been waiting for: performance. For the price, it's incredible. It absolutely smashed what we expected, scoring 1,612 in Cinebench R15, with single-core performance at an impressive 160 points – only 20 behind Intel's top-end Skylake chip. Power wattage was low for an eight-core part though not quite as low as Intel's mainstream consumer chips – but those are still only quad-core parts. Gaming was impressive, too. Across all our 1440p tests, we only saw frame rates differ by 1–2fps at most from the Intel counterparts.

That said, this chip is unusual. Its aggressive price point, insane core count and stunning performance only account for one part of its disruptive nature. Overclocking is a mixed bag, with most 1800Xs only capable of maxing between 4.0 and 4.1GHz on all eight cores. But the real kicker is how the 1800X handles temperature. With a 280mm AIO locked into

place, we recorded idle temps at 50–55°C which is ridiculously hot. We conferred with colleagues and other industry journalists, but they were seeing the same. However, weirdly, under 100% load across all eight cores, the 1800X topped out at 72°C, and then just held it there.

When it's said and done, the Ryzen 7 1800X is phenomenal. For the money, its performance dwarfs the competition, and shines a light on the profit margins Intel has been leveraging over the last few years. Disruptive? Definitely. Is AMD on top again? Time will tell. **— Zak Storey**

Verdict
Features ★★★★★
Performance ★★★★★
Value ★★★★★

VENOM

Venom BlackBook Zero 14

Razer Blade Stealth (2017)

ASUS ROG PG258Q

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.



Australian government sets up first Joint Cyber Security Centre in Brisbane

STRENGTH IN UNITY

The first Australian cyber threat sharing centre has opened in Brisbane, with Federal and State governments working alongside law enforcement agencies. The centre in Brisbane is the start of a \$47 million program aimed at defending the nation's digital networks, part of a much larger \$231 million cyber security strategy that will see similar centres operating in Perth, Adelaide, Melbourne and Sydney. **SS**

Amazon hosting servers go down

TAKING A GOOD CHUNK OF THE 'NET WITH IT

Issues at Amazon's Northern Virginia server farm recently caused widespread outage that impacted numerous cloud-based businesses, websites and services that use the company's S3 web-based storage service. The five-hour breakdown not only 'broke' the internet for millions of users, but even disrupted IoT devices and stalled updates on the Amazon Web Services dashboard. It ironically even brought down outage monitoring sites like DownDetector and isitdownrightnow.com **SS**

Google beats out Apple as world's most valuable brand

CLASH OF THE TITANS

With a 24% increase in brand value over last year's ranking, Google has taken over pole position from Apple who, itself, saw a 27% fall in value. This data comes from Brand Finance Global 500, whose rankings have been dominated by Apple since 2012 where it first rose to the top of the pack, knocking Google off the podium to do so. The fall may be attributed to a wealth of competition in the smartphone market, among other reason. **HD**



Facebook rolls out new 'disputed' label to help identify fake news

Separating the chaff from the grain.

Over half the world's internet users get their news from social media sites like Facebook and Twitter and most swallow the story whole without checking its veracity. After much finger-pointing at Facebook's promotion of fake news during the US Presidential election, Zuckerberg promised to take action and, in a lengthy letter in February, wrote, "We've made progress fighting hoaxes the way we fight spam, but we have more work to do".

Earlier this year, the social media giant announced the outsourcing of fact-checking to third parties and dropping flagged news stories to the bottom of a user's feed. Now there's another tool in town to combat fake news – a 'disputed' tag is being rolled out.

Stories flagged by users as fake are sent to the third-party fact-checkers for validation. If the story is identified as fake and it shows up on user news feeds, it will be accompanied by a 'disputed' warning label, along with a link to the fact-checking sites that will explain why it isn't true. **Sharmishta Sarkar**

New legislation makes it mandatory for Aussie businesses to report data breaches

IT AWAITS THE ROYAL NOD TO BECOME LAW

After being debated for years, the Privacy Amendment (Notifiable Data Breaches) Bill 2016 has finally gone through the House of Representatives and has been passed by the Senate, making it legislation. All it needs is the royal sanction to become law.

The bill applies to organisations subject to the Privacy Act, so state governments, local councils and businesses with a turnover of less than \$3 million a year are exempt. But other organisations in Australia will be legally obliged to inform the Australian Information Commissioner and affected individuals of any 'eligible' data breach. Organisations will have to report breaches within 30 days, with notifications requiring a full description of the breach along with details on the kind of information accessed and how their customers are to deal with the incident.

Failure to comply with the mandatory notification scheme will be "deemed to be an interference with the privacy of an individual" and will incur penalties including fines of up to \$360,000 for individuals and \$1.8 million for corporates.

Sharmishta Sarkar



Twitch to start selling games

WATCH THE CASH STREAM IN.

With Twitch's latest venture, the massively popular live-streaming gaming service will add the ability to purchase the very game you're watching via the stream page. With a simple click you could earn yourself some Twitch-related goodies (such as 'Bits' — the site's currency) as well as earning the streamer themselves 5% of the profit. With an already massive user base, this move could give Steam some serious competition. HD

Yahoo discloses third massive data breach as CEO takes pay cut.

'YAHOO' INDEED.

Another 32 million Yahoo accounts have been hacked over the last two years, it has been revealed, the third such breach to be disclosed by the Californian tech company within the last six months. The compromised accounts were accessed via forged cookies, an exploit that the company now claims has been patched. Yahoo CEO Marissa Mayer has taken a pay cut as a direct result of the breaches and the company's top lawyer has resigned, presumably for a similar reason. HD



Steam will start charging Aussies an extra 10% on games from July

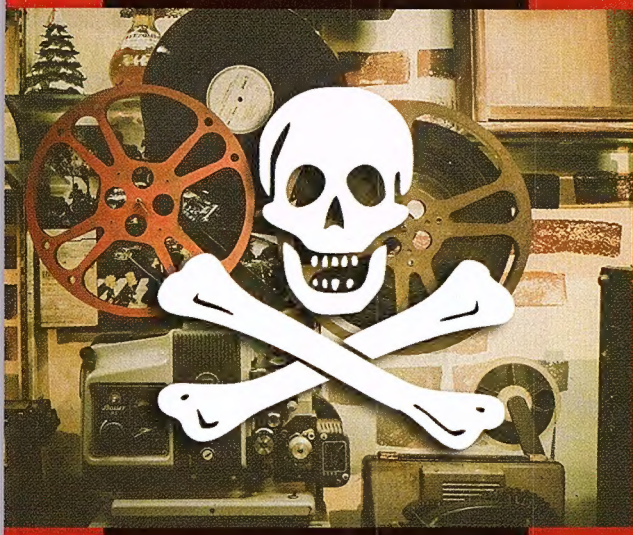
We had it coming, apparently.

While it's been coming for a while, Valve will finally make good on their word (some may say 'threat') and add a 10% goods and services tax on all Australian software purchases through Steam from July, according to a report based on a developer email from Valve. The extra 10% will reportedly be included in the displayed price on the storefront and the tax later separated out, meaning that you will still be paying the price you see on Steam — but it will more than likely be a little steeper.

The Goods and Services Tax is far from news to Australians, with taxes for digital services being mentioned by then-treasurer Joe Hockey back in 2015, but so far the tax has not been applied to the online games network Steam, where prices are currently displayed in USD and then converted by your chosen payment service, be it your bank or PayPal.

It's not just Aussies that will feel the local-tax burn, with national taxes being rolled out from March onwards for Japan, Switzerland, South Korea, Iceland, South Africa, India and to our neighbours in New Zealand, too.

Harry Domanski



74 additional piracy websites blacklisted in Australia

THE BATTLE RAGES ON.

Late last year, entertainment rights-holders Village Roadshow and Foxtel spearheaded an attack on piracy websites, resulting in the Federal Court ruling that all Australian ISP's were to "take reasonable steps to disable access" to five popular piracy sites, including The Pirate Bay, IsoHunt, and more. Village Roadshow is at it again, this time enlisting the help of six other film studios to file a mammoth injunction against a further 74 sites linked with online piracy. As the previous case did not grant the rights-holders a rolling injunction, each new addition to the block list has to be made in a separate injunction such as this.

Among the newly-targeted sites are Demonoid, Bitsnoop, Limetorrents, ExtraTorrent and MegaShare, as well as piratebay.to, an alternative domain for The Pirate Bay, alongside a number of Putlocker domains. The requests have been specifically aimed at Telstra, Optus, TPG and Vocus, as well as these ISPs' subsidiaries although, as the previous case ruled that the onus is on the rights-holders to pay for the blocks themselves, Village Roadshow proposes it pays \$50 per domain blocked. Harry Domanski

technotes

» HARRY DOMANSKI LOOKS AT THE NUMBERS
DRIVING THE BIG TECH NEWS



216,000

AMOUNT OF VR HEADSETS SOLD IN AUSTRALIA THROUGHOUT 2016.

According to market studies by Australian tech research group Telstyle, around 216,000 VR headsets were sold in Australia through the calendar year of 2016, with around 70% of these sales being attributed to mobile VR. From this study, Telstyle's analysts are predicting that "VR penetration will reach 25.5% of households by 2021", with the key driving influences being adoption by AAA games, as well as the emergence of a clear dominating force in the field.



16%

AMOUNT OF AUSSIE WORKERS WHO
FEAR THEY'LL BE REPLACED BY ROBOTS.

In a survey conducted by job-sharing website AirTasker, 16% of Australians think their job will be taken over by a robot in the next five years, which equates to around 3.8 million people apparently living in (what we're assuming is) perpetual robo-fear. Of those surveyed, around 40% agreed that the need for human interaction is the main deterrent preventing more automated roles arising, and out of the industries surveyed, those working in education were the most optimistic about automation creating rather than replacing jobs.



TWICE

HOW MUCH MORE WORRIED PARENTS
ARE ABOUT CYBERBULLYING VERSUS
DRUGS.

According to Telstra's Survey to Screen study, Australian parents are twice as likely to be worried about their child's vulnerability to cyberbullying than to the risks of taking drugs, with two thirds of the participants agreeing they would like to see more relevant anti-bullying help provided to their children. Social media expert Corinna Essa points out the severity of cyberbullying, saying that children are more self-conscious than ever and that the bullying "can follow the person anywhere... and the humiliation can be seen by hundreds, if not thousands".



1 in 2

AMOUNT OF ALL WEBSITES THAT ARE
NOW ENCRYPTED WITH HTTPS.

Based on both Mozilla Firefox and Google Chrome reports on web traffic, the amount of encrypted HTTPS data transmitted has now surpassed that of unencrypted data, which helps to prevent eavesdropping and 'man-in-the-middle' attacks. Internet tech giants such as Google, Facebook and Wikipedia have applied considerable pressure on site operators over the last few years to implement the more secure web protocol, hoping to make it the global standard. Aside from the aforementioned companies, a huge portion of the successful migration is due to web-hosting platforms such as WordPress and Squarespace adopting the protocol.

30 days

JAIL TIME GIVEN TO A DRONE
OPERATOR WHO INJURED TWO WOMEN,
RENDERING ONE UNCONSCIOUS.

During Seattle's 2015 Pride Parade, a drone operated by aerial-photography company owner Paul Skinner crashed into two women, leaving one injured and the other unconscious. Skinner has now been found guilty of reckless endangerment and sentenced to 30 days jail and a \$500 fine for the accident. It's the first time the city has charged someone over the use of a drone in a public space, but it's not likely to be the last given the rise in popularity in drones and increasing number of incident reports.



techbrief

» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK



Cloudbleed connected

A security bug that went unnoticed for months has now been patched, but who has been affected and how can you protect yourself from potential exploitation?

Despite the fact that 'Cloudbleed' sounds like the name of an emo band from the mid 2000s, it's actually a serious security bug that affected content distribution network (CDN) Cloudflare. In September 2016, the company, which also provides internet security and distributed domain name server services to many websites, fell victim to a bug in the HTML parsing software it uses to read data from client websites, leaking sensitive information, including passwords and cookies, over one million times. A member of Google's Project Zero — a team of security analysts hired to uncover zero-day software vulnerabilities — discovered the bug in February 2017 and alerted Cloudflare of the issue. Now, while there have not yet been any reports of that leaked data having been exploited — and the vulnerability itself has thankfully been patched — what can you do to protect yourself and your data from this and similar bugs?

Cloudbleed Indicator

TINYURL.COM/APC440-INDICATOR

How do you know if a website is using Cloudflare or not? This handy Chrome extension (with a Firefox add-on in the making) places a little icon on your browser's toolbar. If it remains greyed out, then you're safe. If the icon changes to a red cloud, then that site has potentially been affected by Cloudbleed's leak, and you may want to consider changing your password to that site, if applicable. While the name 'Cloudbleed Indicator' might seem slightly misleading, we would like to emphasise that this tool does not detect the Cloudbleed bug itself, rather it alerts you of a possible vulnerability to it.

Bleed.Cloud: Reverse the Bleed

BLEED.CLOUD/INDEX.HTML

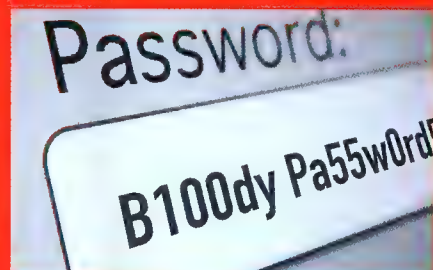
If you'd rather discover whether or not a particular website has potentially been affected without downloading an extension (or if you're not using Chrome), then this website offers a couple of solutions. The easiest involves simply typing or copy-pasting a number of domains into a box, then pressing 'check'. After a brief animation, any of your entered sites that are potentially affected will appear in a grey-pink results box below. More complex solutions involve Python scripts and scanning domains for your accounts.



LastPass

WWW.LASTPASS.COM

If you're not yet using a password manager, stop reading right now and go get yourself one, like LastPass — our favourite free option. Not only are password managers convenient in that you only have to remember your master password (or even sometimes just make sure your fingerprint is still there), it means you can have complex unique passwords for each of your logins, reducing the threat of hacking. Simply enter your sign-in details, secure notes or PIN codes into your password manager — they all work more or less in the same way — and each will display in a searchable list, ready for you whenever you need them. Some even help you by telling you how strong your passwords are, or provide you one that's super secure. One of the best features the advanced managers possess is the password audit function, or 'Security Challenge' in the case of LastPass. Essentially, this is a security measure whereby your manager can alert you to change passwords if the service they're used for has been compromised in some way, such as Cloudbleed. This is a feature you will usually have to run manually, but if you're like us and you have many passwords that you don't remember anyway, the ability for your manager to change them to keep you secure is a massive plus. Most password managers can be used cross-platform, too — including mobile, tablet, desktop and smartwatch versions — and many are free, so you really have no excuse. Get one now!



technotes

» GEAR WE WANT

LEGO BOOST CREATIVE WORKSHOP

\$TBC | LEGO.COM

LEGO: simple bricks, right? Well, the bricks are getting a little bit smart, with the help of the LEGO Boost Creative Toolbox. The Toolbox includes over 840 pieces; the accompanying app provides instructions to build and code five multifunctional models. There's Vernie the talking robot, a multi-tooled Rover 4 transport unit with spring-loaded missile, the Guitar4000 musical instrument, Frankie the interactive cat, and the AutoBuilder – which promises an automated production line for LEGO models. An inspirational update to our favorite interlocking bricks.



BENQ ZOWIE ZONE

\$TBC | ZOWIE.BENQ.COM

In a world where every second household appliance is a smart device, some manufacturers apparently think that the traditional desk just doesn't pull its weight anymore – and after seeing the Zone gaming desk from BenQ, we're tentatively inclined to agree. Hidden beneath the modern ergonomic exterior of this smart-desk is an inbuilt cable management system that'll let you connect your headphones, speakers and PC through conveniently-located ports, and toggle between the outputs from a forward-facing control panel. You can even tweak volume, automatically adjust table height and even turn the PC on and off directly from the table's buttons. Four USB 3.0 ports, two USB 2.0 ports, two power outlets, a fully moveable monitor stand and a PC tower undercarriage mount make this gaming table so much more l33t than any other desk. JB



RETROBLOX

\$TBC | RETROBLOX.COM

Although modern games now have production values and storytelling to rival Hollywood blockbusters, sometimes you just can't beat the classics. Replaying them can be a labour of love: you have to find working consoles, and you'll often need a CRT television to play them on. Labour no more, because the upcoming modular multi-system gaming console RetroBlox promises to play them all in high definition. Its CD/DVD drive will gobble any retro disc you throw at it, and the cartridge module accepts silicon from the Atari 2600, Super Nintendo, Mega Drive 32X and more. SL





CAAVO

US\$399 | WWW.CAAVO.COM

Considering that Netflix, Stan, local TV catch-up apps, your gaming consoles, a Blu-ray player and even actual free to air are (probably) all running through your TV, switching between our modern cavalcade of entertainment sources from the couch has become a more complicated procedure than ever. Determined to rectify this 'urgent' inconvenience is an enclave of developers, apparently hand picked from the ranks of Sling, Dish and Xbox, who have banded together to bring the world an eight-port wood-trimmed HDMI receiver called Caavo. Designed to automatically recognise any of your living room devices, optimise their input settings and centralise remote communication, this device hopes to amalgamate and simplify the complicated array of entertainment sources in the living room. **JB**

SHADECRAFT SUNFLOWER

STBC | SHADECRAFT.COM

This impressive new addition to the Internet of Things, albeit in prototype mode at present, does a lot more than keep you cool on a hot day. The Sunflower is the first autonomous robotic shade; it's solar-powered and boasts an integrated camera for security, controlled lighting, a speaker system, and charging facilities. As it tracks the sun, it optimises both its solar charging capacity and its ability to provide shade. The Sunflower is Bluetooth and Wi-Fi enabled, and the app allows you to check in on the weather, UV levels, and air quality.



AIRBOLT SMART TRAVEL LOCK

US\$80 | THEAIRBOLT.COM

Keep an eye on your bags with the new AirBolt smart lock, which you control over Bluetooth from an app on your iPhone. This can track your bag too, sounding a buzzer if it starts to move beyond Bluetooth range. If the bag truly gets lost, the lock can message other AirBolt users nearby and prompt the companion app on their phones to tell you where your bag is, anywhere in the world. **■**



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



We're a huge fan of easy-to-remove components.



Sony PlayStation 4 Pro

A look at the guts of Sony's 'professional' gaming console.

The world of video game platforms has been changing quickly. Manufacturers have resorted to mid-gen refreshes to keep up with 4K TVs and VR headsets, and here's the third iteration of the PS4 generation. We may be amateur gamers, but we're revved up to tear the PlayStation 4 Pro down, professionally.

MAJOR TECH SPECS

- Eight-core AMD 'Jaguar' X86-64 CPU, clocked at 2.1GHz (up from 1.6GHz)
- 4.2Tflops AMD Radeon-based graphics
- 8GB GDDR5 RAM and 1GB DRAM
- 1TB removable and upgradable hard drive storage
- 802.11a/b/g/n/ac, Ethernet and Bluetooth 4.0 (LE)
- Blu-ray x6 CAV, DVD x8 CAV

KEY FINDINGS

- The triple-decker design is a little different from the 'first' PlayStation 4, but that doesn't stop us — without

wasting time, we flip the console over, pop the first panel, and hit pay dirt! A single, standard Phillips #0 screw stands between us and hard-drive-swapping glory.

- We're going to have to remove the 'Warranty void if seal removed' stickers to go any further. Adding insult to injury, the screws hidden beneath are Security Torx screws — designed to stop you getting in. With the case cracked open, we can remove a large metal shield. Unfortunately, all this does is give us a view of the motherboard's backside.
- With the beast on its back, the opposite panel pops off after some prodigious prying — but no 'warranty void' stickers! Alas, removing this panel isn't the panel-kea we were hoping for. We can pull out the power supply, but nothing else. While you can't remove the fan, you could certainly clean it from here — maybe that's why we're granted this non-warranty-voiding access zone.

- Thwarted by the lack of any more screw heads on the PSU side of the PS4 Pro, we flip it back over and turn our attention to the motherboard. Burrowing through a layer of shielding behind the CPU reveals a cool X-shaped retaining bracket, similar to ones we found in another console. And directly underneath it, we dig up a plastic and metal cover that seems to be the consumer electronics version of a pizza saver, protecting the back of the board from the heatsink retaining bracket.
- **Repairability Score:** 8 out of 10 (10 is easiest to repair). No adhesive makes disassembly and reassembly easy. The non-proprietary hard drive is simple to access, upgrade or replace and doing so doesn't void your warranty. While you can clean the fan, removing it and other components requires warranty-voiding disassembly. Security screws and tamper-evident seals discourage users from disassembling and repairing their PlayStation 4 Pro. ■



GIGABYTE EXCLUSIVE SWAPPABLE OVERLAY FOR
ACCENT LEDS AND MEMORY LED DIFFUSERS

AMD
SOCKET
AM4

X370

SUPPORTS ALL AMD AM4 PROCESSORS
AMD.COM/AM4

RYZEN

GREATNESS WITHIN

GIGABYTE AORUS GAMING MOTHERBOARDS

- > 8-CORE SUPPORT WITH EXTREME DIGITAL POWER OVERCLOCKING
- > POWERFUL GAMING AUDIO WITH DUAL SMART HEADPHONE AMPS
- > VR GAMING READY WITH ADJUSTABLE VOLTAGE USB DAC-UP 2

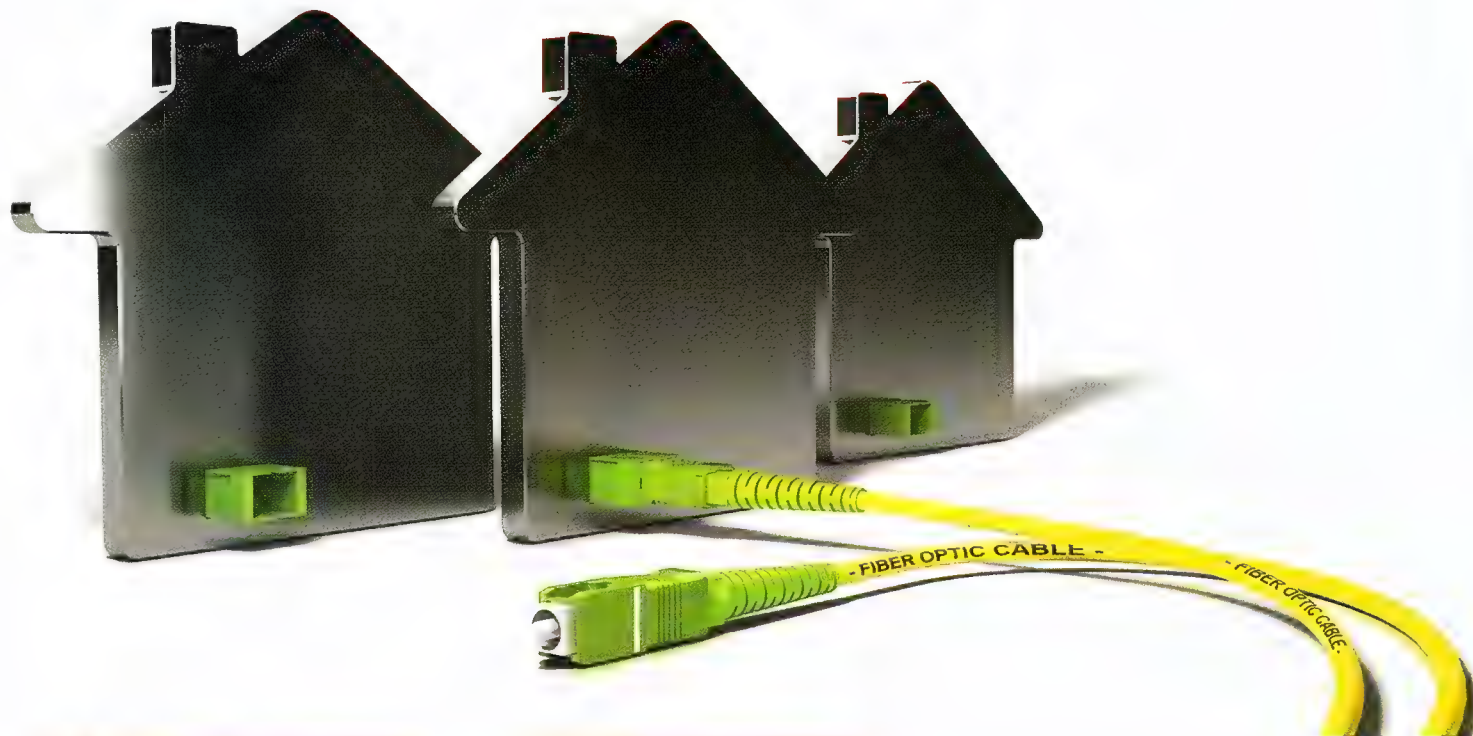


Sound
BLASTER
X-Fi 5



technotes

» EPINIONS



NBN UPGRADE A MIXED BAG

I have seen many horror stories about FTTN connections in your magazine and in others. I would, therefore, like to share with you my successful transition from ADSL. The new gateway was delivered one day after the order was placed. On the cutover day (7 days after order placed), I connected the new gateway. There was only a 10 minute loss of internet during cutover and, once cut over, the speed went from 5.4Mbps down and 0.7Mbps up to 28Mbps down and 6.4Mbps up.

The link is a constant 28/6.4 but during busy periods a speed test gives results of 5Mbps down, 4Mbps up. My understanding is that this is not due to the FTTN technology, but due to my retail service provider (RSP) not providing sufficient capacity per customer from node to their central gateway and between their gateway and the rest of the internet. I believe that RSP's should be obliged to provide the capacity per customer they provide from the node to the internet.

Carl Francis

AN APC FAN SINCE DAY ONE

I'm in my 70s and have enjoyed computing since the early days of PCs – when Apple, Commodore and Tandy ruled the roost (1979 in Australia), and Tandy and Dick Smith fought it out with electronics and computers, and APC has been one of my friends along the way. APC has outlasted a lot of others in the magazines.

I have desktops, portables, tablets and a Windows phone, but still prefer the old desktop (but I do like the all-in-ones), and APC certainly helps in keeping me up to date. I don't feel the desire to send messages every five minutes, and anyway, some of my friends are in their 80s, and prefer desktops.

I use 'Dr Google' and scientific websites (including the US Government's National Institute of Health (NIH), the world's largest medical research body), to collect the information.

Like Sean Howard, who founded APC, I started a degree in medicine, but didn't finish, but can make complex

medical discoveries understandable or more understandable to most people. I do this via websites and blogs, and three archived websites are still very popular, world-wide, and I've just moved on to broadband, and plan more. APC has been very, very useful in helping me keep my technology in workable order.

I thought you'd like to know one story of the value of modern technology. The world wide web is helping us in many ways, but none more important than in making vital knowledge more freely available. More and more medical research is being reported via free websites, thus helping the poor and disadvantaged. There is a huge amount of medical misinformation on the internet, on radio and on TV shows.

This all keeps my brain busy, which is more vital, the older one gets.

Laurie O'Shea ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



technotes

» END USER

Is the CIA knocking at your back door?

In a world that's engaged in more frequent debates around digital privacy and national security, Harry Domanski pokes through some of the details in the latest WikiLeaks documents.

In the most recent WikiLeaks data dump – titled Vault 7 'Year Zero' (which apparently accounts for less than 1% of the entire Vault 7 series) – the whistle-blowing organisation has leaked 8,761 US-government documents that expose a plethora of the CIA's sneaky hacking practices; in particular the agency's penchant for exploiting Android and iOS devices. Naturally, the leak has spread like an office flu and has gone hyperbolic mutations across the globe's media networks, from peak apocalypse to: "That's old news, man," – so should we panic or shrug?

A little of both seems appropriate. For the most part, many of the Android and iOS exploits that were revealed have been known about by both consumers and Google and Apple for some time, and have since been fixed without too much public fuss. This has been supported by statements from Apple (which has declared that "many of the issues" are already fixed) and Samsung (which is "urgently looking into the matter"). However, this does

suggest that some exploits are still at large and we don't necessarily know which ones – which may be a blessing in disguise given that any criminals who are looking to deploy those exploits are likely in the same boat.

One of the scarier examples is a hack codenamed Weeping Angel (referencing the terrifying *Doctor Who* statue monsters) that essentially turns your smart TV into an Orwellian 'telescreen', able to pick up audio and video in the room even when the device appears to be off. Thankfully, this only applies to select Samsung smart TVs released in 2012 and 2013, and those still running now-outdated firmware (versions 1111, 1112 and 1116), so as long as you've updated your TV you should be fine. (That said, it's worth noting that Samsung's own data collection policies may be a bit intrusive, particularly with their Smart TVs, so you may want to check your TV's privacy policy anyway.)

As always, the safest way to prevent breaches in your privacy (be that from corporate, government or criminal sources) is to employ a healthy dose of

common sense. Keep your devices up to date, as most major manufacturers continuously release security fixes in their latest firmware patches. Unless you know what you're doing, avoid third-party app stores and, where possible, do cursory research into any app you plan on installing – check their reviews and especially the permissions they require. And lastly, if your device has some 'smart' functionality that you don't actually use, such as Bluetooth or automatic voice and video recording, then turn it off – get to know your device's settings and features.

What's alarming is that the leaks give us more tangible evidence that government agencies are abusing our connected lives for surveillance purposes and, in doing so, raises further questions about the blurred line between personal privacy rights and issues of national security. This extra media and public attention was no doubt the intention of WikiLeaks when releasing these documents, but whether or not it invokes any kind of policy change is yet to be seen. ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

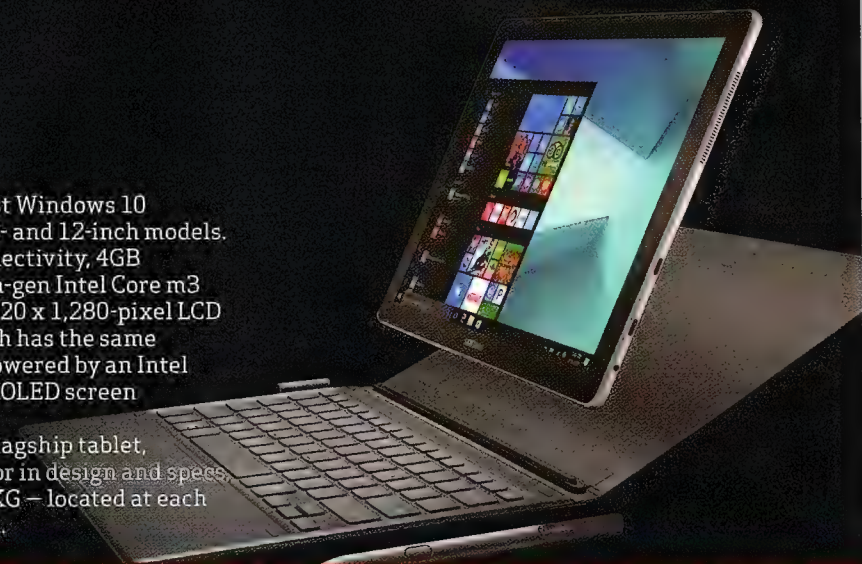
Samsung Galaxy Book

More from a Galaxy near you.

PRICE & AVAILABILITY TBA

Another highlight at MWC 2017 was Samsung's latest Windows 10 'Surface-killer' tablet, which is set to come in both 10- and 12-inch models. The Galaxy Book 10 features integrated 4G LTE connectivity, 4GB memory, either 64GB or 128GB storage and a seventh-gen Intel Core m3 processor. There's also a 5MP front camera on the 1,920 x 1,280-pixel LCD display. On the other hand, the Galaxy Book 12, which has the same storage and memory specs as the 10-inch model, is powered by an Intel Core i5 processor and boasts a 2,160 x 1,440-pixel AMOLED screen with 216ppi pixel density.

Samsung also announced its new Android-toting flagship tablet, the Galaxy Tab S3. Similar to its iPad-like predecessor in design and specs, it sports four speakers — made by Harman-owned AKG — located at each corner of the device and comes with a next-gen S Pen.



MWC 2017

THE BEST BITS OF KIT

BARCELONA'S ANNUAL MOBILE WORLD CONGRESS HAS BECOME THE PREMIERE EVENT FOR ALL THINGS SMARTPHONE, BUT THE SPREAD OF MOBILE TECH HAS ALSO MEANT THAT, IN RECENT YEARS, MWC HAS BECOME A SHOW ABOUT MUCH MORE THAN PHONES. SHARMISHTA SARKAR AND HARRY DOMANSKI REVEAL APC'S FAVOURITE PRODUCTS FROM THE 2017 EVENT.



Nokia 3310

What do you mean it's back?

STBA | AVAILABILITY TBC (UNLIKELY FOR AU)

The only thing more curious than the revival of this 17-year-old Nokia phone at this year's MWC is perhaps the massive attention it's garnered. Some critics are speculating that the interest in this 'dumbphone' (or 'feature phone') is more than just successful nostalgia-driven marketing, but is actually the death rattle of a smartphone market that can (apparently) offer nothing truly different from last year's models... Either way, the new 3310 has a 2MP camera, 2.4-inch colour screen and comes with a revamped version of Snake. The big caveat is that it also only has 2G connectivity and no Wi-Fi, meaning it will likely not be available in Australia, or at the very least, won't work here — and in many other countries too.

Samsung Gear VR with controller

Same-ish gear, new controller.

STBA | AVAILABILITY TBA

It makes sense that Samsung has brought a new iteration of its Gear VR headset to the table. Perhaps the most anticipated news is that the new Gear VR will ship with its own controller, finally giving you something to do with your hands and bringing it up to par with Google's recently-released Daydream View headset. The Samsung controller features a flat touchpad, some buttons and a trigger, as well as a plethora of sensors for motion input and spatial awareness. Other headset upgrades include an improved field of vision and distortion correction, hopefully minimising motion sickness, and Samsung's announced there are 70 supported titles currently in development to boot.

BlackBerry KeyOne

A blast from the past.

US\$549 (AROUND \$810) | AVAILABLE GLOBALLY FROM APRIL

Originally announced at CES in January, TCL unveiled the latest BlackBerry flagship at MWC, marking the return of the physical keyboard. Officially christened the KeyOne (not 'Mercury' as it was unofficially codenamed), the handset combines the BlackBerry Classic design with the BlackBerry DTEK50 software. There's even a fingerprint sensor neatly tucked into the space bar of that good ol' QWERTY keyboard. The phone will run Android 7.1 (Nougat) and come with highly secure encryption that should meet governmental needs. There's a mid-range Snapdragon 625 chip and 3GB RAM to drive the show, with 32GB of storage available, which can be expanded further by up to 256GB via a microSD slot.

Porsche Design Book One

Fast cars to fast computers.

US\$2,495 (AROUND AU\$3,250) | AVAILABLE FROM APRIL IN THE US

From concept cars to handheld devices, Porsche wants to rule them all. Having previously teamed up with Huawei for a 'Porsche Design' edition of the Mate 9 smartphone, the German manufacturer has now unveiled its first laptop. Porsche Design's 13-inch Book One looks very similar to Microsoft's Surface Book, but noteworthy is the Book One's hinge. It not only allows the display to rotate a full 360 degrees but, with the push of a button, can also detach from the keyboard, transforming it into a true tablet. It also allows the display to close over the keyboard without a gap, unlike many other 360° 2-in-1 designs. Inside, it comes packing one of Intel's latest Core i7 CPUs, plus 16GB of RAM and 512GB of SSD storage.



Lenovo Yoga 720

Bending over backwards.

STBA | APRIL 2017

Available in 13- and 15-inch models, the Lenovo Yoga 720 looks like it could be the first viable 2-in-1 gaming laptop. There'll be several configurations available, including choices between Full or Ultra HD touchscreen displays, up to 16GB memory, and the option of the latest seventh-gen Intel Core i7 processors. The 15-inch model will get some premium perks such as a bigger battery and the option of the new GeForce GTX 1050 GPU and SSD storage up to 1TB. Interestingly, the 15-inch model will only offer up to 8GB of RAM, although apparently it's manually upgradeable to a max of 16GB, hinting at some user-friendly tweakability.

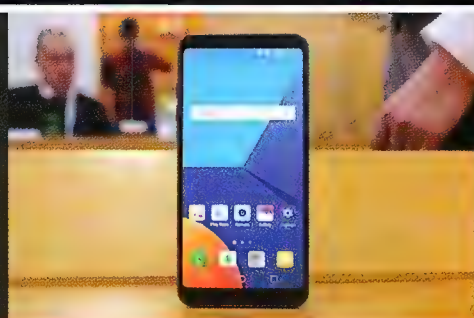


Sony Xperia Touch projector

Almost like Minority Report...

STBA | AUTUMN 2017

Interactive projectors have so far been mostly limited to underwhelming and unresponsive Bluetooth laser keyboards for mobile — Sony's Xperia Touch Projector promises to be more. The large box-like object, looking somewhat like the lovechild of a Bluetooth speaker and an external hard drive, runs Android and is capable of projecting a 720p display (ranging from 23 to 80 inches in size) onto any surface. It uses infrared sensors to detect your gestures and movements, allowing you to interact as you would with a tablet, and intends to include smart-home functionality with a wealth of included sensors, such as temperature, GPS, ambient light, barometer and more.



LG G6

Best in show, said everyone.

STBA | AVAILABLE FROM LATE MARCH

LG's latest flagship handset has been labelled game-changing, with its nearly bezel-less 5.7-inch, 18:9 aspect-ratio display. It's also the first third-party phone to officially feature Google Assistant out of the box (which launched last year on the Pixel and Pixel XL). The conservative design drops the removable battery but adds a larger-capacity power pack inside a newly waterproof body. That said, the phone isn't powered by Qualcomm's very-latest Snapdragon 835 chipset as some were hoping, instead sticking with the tried-and-tested 821 from last year. LG could definitely do with a win in the smartphone market to get ahead of Apple and Samsung — and from the positive reaction on the show floor, the G6 could just be the answer.

the lab

» LATEST REVIEWS



AMD CPU

\$699 | WWW.AMD.COM

AMD Ryzen 7 1800X

The Red Wedding.

It's hard to deny how much hype the Ryzen has generated, with many hoping that it would shake up the market, and unseat Intel from its perch of pride. So has it met our expectations? And is it worthy of the hype?

The Ryzen 7 1800X is an octa-core, 16-thread, 14nm behemoth of a processor. Each core sports 64KB of L1 cache, followed by 512KB of L2 cache, and 8MB of L3 cache shared between each set of four cores, giving each R7 series chip a combined total of 16MB of L3. Instead of allocating 2MB to each core, the cache is shared across each set of four.

So what's the difference between all the 7-series chips? It mostly comes down to two things: clock speeds and TDP. At the very bottom of the ladder is the Ryzen 7 1700, with a clock speed of 3GHz at stock, boosting to 3.7GHz, and a 65W TDP. If overclocking isn't your jam, this is perfect. Next is the 1700X, with a 3.4/3.8GHz clock speed, and a 95W TDP,

so if you're after a content creator on a budget, this one is ideal. Lastly, the 1800X, still touting that 95W TDP, but with a base clock of 3.6GHz, turboing up to 4.0GHz when the situation demands. If you want the absolute maximum, you'll go for this little beauty.

On top of the TDP and clock speed variance, the X-series processors come with AMD's latest SenseMi software suite, including one neat little inclusion in the form of extended frequency range (XFR). Think of it as GPU boost for processors. Thanks to Ryzen incorporating over 1,000 different sensors into each chip, it can detect how much voltage is being directed to each area, and how well the chip is being cooled, then overlocks individual cores as necessary, boosting frequencies by 50-100MHz. Although not hugely impressive considering how little overclocking potential the R7 series has, it bodes well for AMD's future chip design.

Now the bit you've been waiting for: performance. For the price, it's incredible. It absolutely smashed what we expected, scoring 1,612 in Cinebench R15, with single-core performance at an impressive 160 points – only 20 behind Intel's top-end Skylake chips. Power wattage was low for an eight-core part, though not quite as low as Intel's mainstream consumer chips – but those are still only quad-core parts. Gaming was impressive, too. Across all our 1440p tests, we only saw frame rates differ by 1-2fps at most from the Intel counterparts.

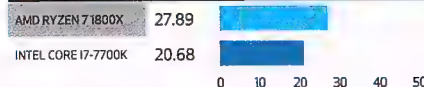
That said, this chip is unusual. Its aggressive price point, insane core count and stunning performance only account for one part of its disruptive nature. Overclocking is a mixed bag, with most 1800Xs only capable of maxing between 4.0 and 4.1GHz on all eight cores. But the real kicker is how the 1800X handles temperatures. With a 280mm AIO locked into

place, we recorded idle temps at 50-60°C, which is ridiculously hot. We conferred with colleagues and other industry journalists, but they were seeing the same. However, weirdly, under 100% load across all eight cores, the 1800X topped out at 73°C, and then just held it there.

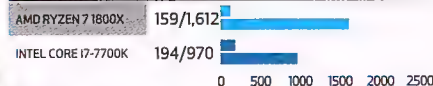
When all's said and done, the Ryzen 7 1800X is phenomenal. For the money, its performance dwarfs the competition, and shines a light on the profit margins Intel has been leveraging over the last few years. Disruptive? Definitely. Is AMD on top again? Time will tell. ■ Zak Storey

LABS BENCHMARK RESULTS

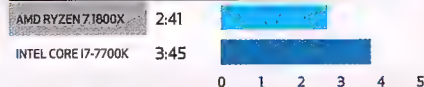
X265 BENCHMARK (FPS)



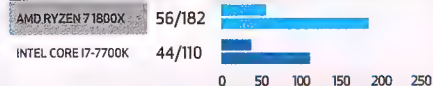
CINEBENCH R15 SINGLE/MULTI (INDEX)



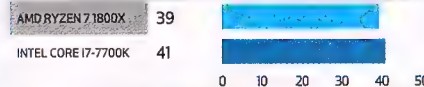
FRYRENDER BENCHMARK (M:S)



POWER DRAW IDLE/LOAD (W)



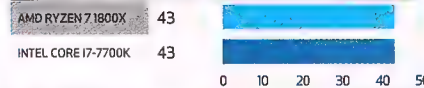
TOTAL WAR: ATTILA @ 1440P (FPS)



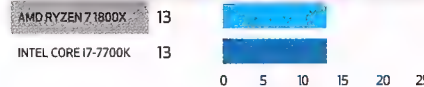
FAR CRY PRIMAL @ 1440P (FPS)



RISE OF THE TOMB RAIDER @ 1440P (FPS)



DEUS EX: MANKIND DIVIDED @ 1440P (FPS)



Verdict

Features
Performance
Value



Stunning multi-core performance, solid single-core support, advanced feature set and good TDP, but at an insane price.





AMD AM4 MOTHERBOARD

\$369 | WWW.ASUS.COM/AU

ASUS RoG Crosshair VI Hero

Welcome to the AM4 chipset!

AMD has always prided itself on maintaining a resolute socket type, requiring only a BIOS update to enable its latest performance powerhouses to operate with impunity. Which has meant that both chipset updates and connectivity have suffered.

With the launch of Ryzen and the AM4 socket, on the other hand, it seems this state of affairs may be changing in the rouge ecosystem. Taking a quick glance at AMD's X370 chipset and comparing it to Intel's Z270, you'd be justified in feeling slightly underwhelmed. It's only

when you take a look at what Ryzen (the processor) directly supports that you get a better understanding of how this platform will work. By default, all of Ryzen's 7 series will support four USB 3.0 ports, four USB 2.0 ports, 16 Gen 3.0 dedicated graphics PCIe lanes, an additional four PCIe 3.0 lanes for "general use" (read: "NVMe SSD") and an additional four PCIe 3.0 lanes for chipset communication. Which brings it close to its Kaby competition, although without support for more than a single M.2 PCIe SSD.

Now ASUS's Crosshair VI Hero is the first X370 mobo

we've had in the labs for testing, and it's just about everything we want in a board. With support for DDR4 up to 3,200MHz, two 16 PCIe 3.0 slots, eight SATA 6Gb/s ports, a single M.2 PCIe x4 port, a plethora of fan headers and a snazzy rear I/O, it's very good value for money. There's no integrated graphics support, but to be quite frank, it's not needed with any of the three processors. The VRM solution is substantial, and having an eight-pin EPS power, plus an additional four-pin 12V CPU power, has allowed this mobo to clock up to 5.2GHz with some record-breaking chips.

The biggest benefit the Hero has over its competition, though, is down to the cooler support. AM4 has, rather annoyingly, come with an ever-so-slightly different mounting solution from its AM3+ predecessor's design. However, the Hero has mounting holes for both AM3+ and AM4 coolers.

Although we can't give any word on comparative performance just yet, overall, it seems solid in contrast to the Intel alternatives, and we're happy to give it our seal of approval for anyone looking to get into the new AM4 platform. ■ Zak Storey

BENCHMARK RESULTS

	AMD X370	INTEL Z270	INTEL X99
USB 3.1/3.0/2.0	2/10/10	0/10/14	0/14/8
SATA 6GBPS	10 (OR 8+1 NVME PCIE SSD)	6	10
MEMORY CHANNELS	DUAL-CHANNEL	DUAL-CHANNEL	QUAD-CHANNEL
MAX MEMORY FREQUENCY	2,666MT/S	2,400MT/S	2,400MT/S
NUMBER OF PCIE 3.0 LANES	20 (20 CPU, 0 CHIPSET)	40 (16 CPU, 24 CHIPSET)	40 (40 CPU, 0 CHIPSET)
NUMBER OF PCIE 2.0 LANES	8	0	8
NVME PCIE SSD SUPPORT	1	2	2

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

With fantastic rear I/O, strong overclocking and DDR4 support up to 3,200MHz, it's great value.



✓✓✓
apc
RECOMMENDS



MOTHERBOARD

\$199 | AU.MSI.COM

MSI H270 Tomahawk Arctic

Thankfully not frozen in time.

Hailing from MSI's Arsenal Gaming range in Intel motherboard (a series based on military themes and presenting gaming-centric features), the H270 Tomahawk Arctic also represents the first H270-based board we've had in the APC lab.

The Tomahawk is also available in a Z270 variant, the aptly named Z270 Tomahawk (black-red colour theme) and Z270 Tomahawk Arctic (white-blue in colour). The core differentiators between the Z270 and H270 based variants of these boards is the inclusion of overclocking, specifically support for K-series CPUs and memory frequencies greater than DDR4-2400, and an extra four PCIe 3.0 lanes on Z270 (24 lanes for Z270 versus 20 lanes for H270). If neither of these attributes concerns you, the H270 variant will – for the most part – deliver a comparable experience for the average user – those who aren't fussed about

tweaking for additional performance beyond stock defaults or using numerous PCIe based storage and expansion devices.

Understanding the PCIe resource allocation on this motherboard is important to making an informed purchasing decision. Due to having more PCIe-based connectivity options than PCIe lanes available to the platform, resources are shifted around the motherboard's features to meet connectivity demands – meaning you can't expect to use all the features at once. For example, the second PCIe x16 slot (operating at PCIe x4) disengages and reallocates the PCIe lanes to the second M.2 port when a device is installed in the M2 2 port. Similarly, when PCIe slots #3 and #6 are used, this disables slots #2 and #5 as the PCIe lanes are shared. Furthermore, be mindful that the second and third PCIe x16 slots are running PCIe x4 and PCIe x1 link speeds and only the primary

PCIe x16 slot has full 16 lanes of PCIe connectivity. Due to the second PCIe x16 having an x4 link, only AMD CrossFire is supported on this platform, with Nvidia SLI specs requiring at least x8 link speed for each GPU.

On the back, the rear I/O is reasonably well kitted out, providing two USB 3.1 ports across a Type-A and Type-C port combo, four USB 3.0 ports and, finally, a couple of USB 2.0 ports too. Also present are HDMI and DVI-D outs, a PS/2 port focused towards gaming-related peripherals and an audio I/O stack with five 3.5mm sockets supporting 7.1 surround sound paired with an optical link, supplied by the Realtek ALC891 codec. The rear I/O is rounded out by the inclusion of an Intel i219-V backed Ethernet port with a software layer that facilitates gaming QoS prioritisation via the MSI Gaming LAN Manager app, scoped to deliver reduced latency and thereby a smoother online gaming experience.

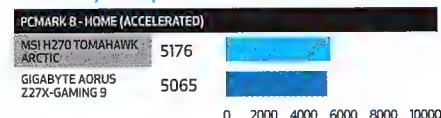
The ever-present RGB support is delivered by a single RGB header on the bottom left of the board. This is controlled by the MSI Mystic Lights Sync software and allows individual configuration or synchronisation of the RGB header, supporting MSI RGB expansion products (read: GPUs) and third-party vendor hardware solutions from the likes of Corsair, G.Skill, Cooler Master, In Win and others.

Overall, this is a nice board with good features – so long as your needs fit within the scope and function of its 'juggle things around' design.

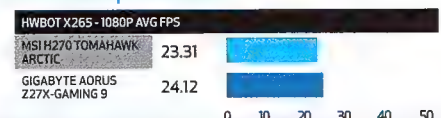
■ Josh Collins

LABS BENCHMARK RESULTS

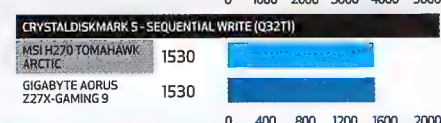
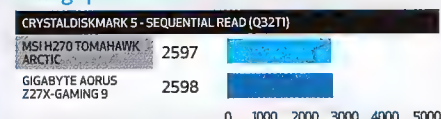
General system performance



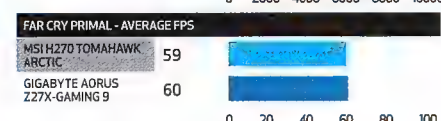
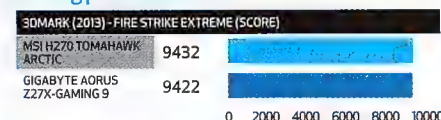
Multimedia performance



Storage performance



Gaming performance



Verdict

Features
Performance
Value



If your needs fit the scope of this board, then you're in for an enjoyable user experience at a decent price.





INTEL Z270 MOTHERBOARD

\$319 | WWW.ASUS.COM/AU

ASUS RoG Strix Z270G Gaming

The Strix glides into position.

This is the first Strix motherboard in the pages of APC, with the range derived from a confused heritage of mid-tier gaming orientated motherboard products that previously sat outside the umbrella of ASUS's premium Republic of Gamers (RoG) family. Yet, this board's lineage has previously knocked on the RoG door and had a slightly awkward relationship. The lineage started two generations back with the Intel 9-series based 'Pro Gamer' family, which evolved into the Intel 100-series 'Pro Gaming' range, then again into this Intel 200-series 'RoG Strix Gaming' range.

However, it's now competing against a full suite of mid-tier RoG motherboards – something that's a bit of a double-edged sword for ASUS. On the positive side, with this Strix joining the fray, the RoG brand's no longer just focused on high-end products, such as the

Maximus, Rampage and Crosshair lines. However, the negative for ASUS is that, by introducing a lower-positioned range within the RoG stack, it could diminish the brand's premium 'gaming' position – something it's held and maintained for the past decade, long before the 'Gaming' moniker craze.

There've been efforts to lower the cost of entry to the RoG range in previous generations, and in many ways, it feels like the Strix Z270G Gaming is the spiritual successor to the Maximus VIII Gene – and we're informed there's unlikely to be a IX Gene this year. The Gene model evolved to garner a strong following in the micro-ATX enthusiast niche and it appears the Strix Z270G Gaming is set to continue that reputation.

Spec-wise, the Strix Z270G Gaming ticks the desired boxes and the 24 PCIe lanes of a Z270 Kaby Lake setup paired with the micro-ATX form factor leads

to a fully featured board, reducing resource compromises (unlike on the MSI H270, opposite). The primary PCIe x16 slot draws its PCIe lane allocation directly from the CPU and splits this into two PCIe x8 links across the primary and secondary PCIe x16 slot to accommodate SLI and CrossFire multi-GPU support. The motherboard also supports two M.2 ports allowing for RAID configuration, even with a multi-GPU setup and all SATA ports in use.

Audio's handled by the Realtek ALC S1220A codec paired with dual Texas Instruments operational amplifiers (RC4580 and OPA1688), audio-focused Nichicon capacitors and wrapped up under the RoG SupremeFX audio tech branding. However, it's important to note that not all SupremeFX configs are made equal and this unit won't compete with, for example, the SupremeFX solution found on the RoG Maximus IX Formula.

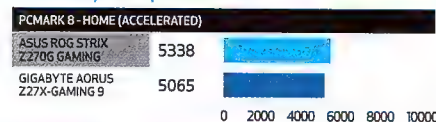
With dual RGB headers – one in the bottom left sector, another in the top right – paired with extensive RGB control via the ASUS Aura Sync software, configuration is possible across the RGB features of the motherboard, Strix RGB GPU range, RoG RGB peripherals and third-party RGB hardware from the likes of In Win, NZXT, Bitfenix, Cablemod, Cooler Master, EKWB, G.Skill and others.

Dare we say it, this is a very neat little 'board – and with it, the ASUS mid-tier gaming motherboard range has finally come of age.

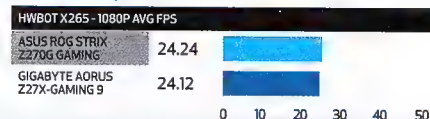
Josh Collins

LABS BENCHMARK RESULTS

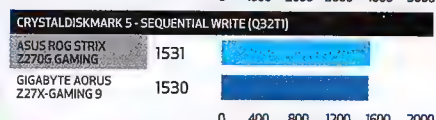
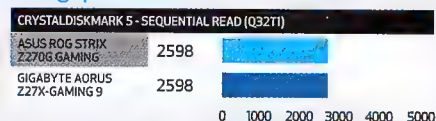
General system performance



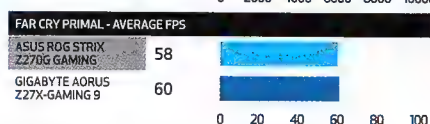
Multimedia performance



Storage performance



Gaming performance

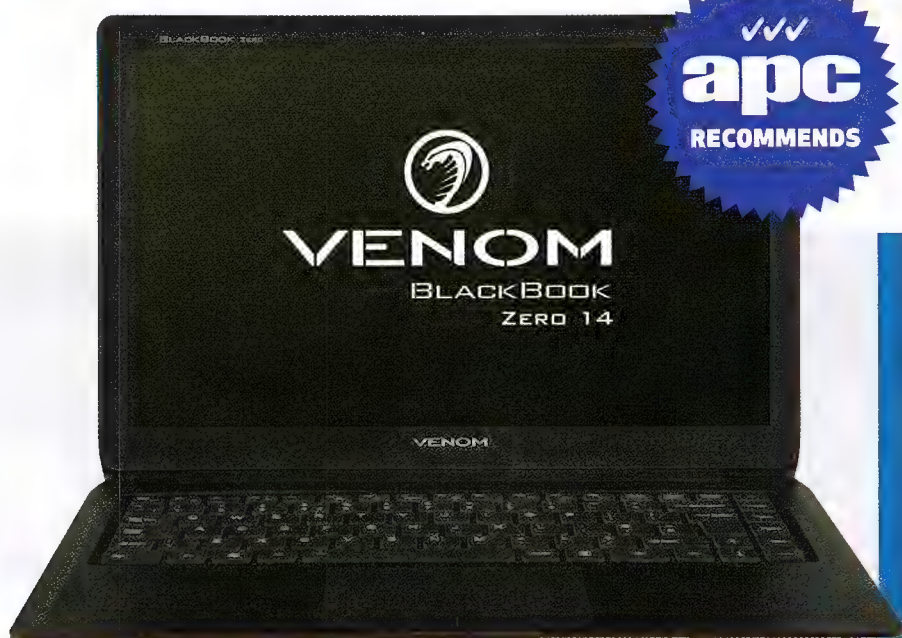


Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A fully featured, kitted-out micro-ATX LAN gaming setup for end-users conscious of the system's footprint.





LAPTOP

FROM \$1,499; AS TESTED, \$1,699 (CORE I5-7Y54, 8GB RAM, 240GB SSD)
WWW.VENOMCOMPUTERS.COM.AU

Venom BlackBook Zero 14

A compact but tough professional ultraportable... with a bit of bite.

The BlackBook Zero 14 isn't quite the thinnest ultrabook we've seen, nor is it the lightest. It isn't the most expensive, the most affordable or, really, the most anything. What the Zero 14 is, however, is the measured realisation of a clear and desirable design concept. From the unusual inclusion of two power adapters, the lightweight design and the power efficient seventh-gen Intel Core i5 or i7 CPU, it's clear that the Zero is aiming for the title of best ultraportable pro laptop.

Honed from a black sandblasted metal alloy composite, this 1.4kg clamshell is around 15% heavier than most 2-in-1s and ultrabooks that you'd generally pit it against. This higher weight might seem counter-intuitive, but when you consider that it's largely due to that sturdy metal chassis combined with a

slightly bigger screen (it's 14.1 inches rather than the usual 13.3), that's a trade-off we reckon many will be willing to take.

Its black-keyed chiclet keyboard feels notably deeper and has a stronger, firmer key feedback than almost any laptop we've tested. While we have no complaints with the powdery temperament of the BlackBook Zero 14's trackpad, it's still a little shy of MacBook or even ASUS levels of performance.

Things get a little less clear when it comes to the CPU. If CPUs weren't confusing enough, with its seventh-gen Core parts, Intel has decided to adopt the naming convention of its traditionally more powerful mobile units (Core i3, i5 and i7) in the efficient but lower performing Core M range, as seen in the laptop's Intel Core i5-7Y54. This CPU allows Zero 14 to get away without internal fans –

stressing to a conservative maximum of just 86°C – and that allows the screen and bottom chassis to slide in at under 14mm apiece.

When running PCMark 8's general home usage and work benchmarks, the Zero hits 3,088 and 4,210 – scores that are almost identical to the ASUS ZenBook Flip UX360UA's (see opposite) more powerful Core i5-6200U chip. Where the Core M chips don't hold up so well is in intensive multimedia work, like Cinebench's multi-threaded and single core CPU benchmarks where the UX360UA's older Core i5 came off better with scores of 268 and 112, against the BlackBook's 174 and 71. The same held for GPU-heavy tasks, with the UX360UA's Intel HD Graphics 520 netting 38fps in Cinebench's OpenGL graphics benchmark, to the Zero 14's Intel HD Graphics 615, which only managed

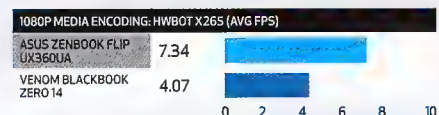
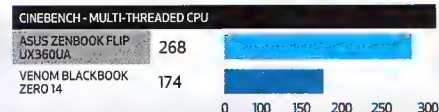
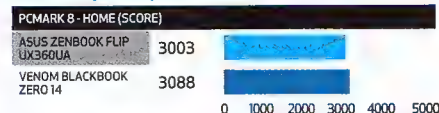
25fps. So the BlackBook Zero 14 isn't quite as versatile as it could be, but it at least manages to keep up in the most important areas.

The Zero 14 stretched the demanding PCMark 8 Home (Accelerated) battery benchmark out to a decent 4 hours and 51 minutes.

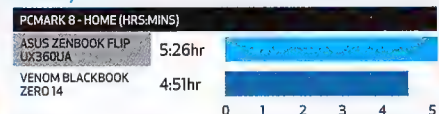
Venom has, overall, done a good job keeping the Zero to the 'professional user' brief. If you're looking for a compact Windows machine for getting stuff done, this super-sturdy 14-inch clamshell deserves your attention. ■ Joel Burgess

LABS BENCHMARK RESULTS

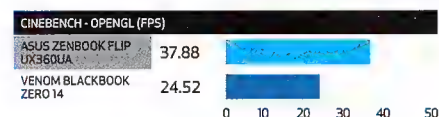
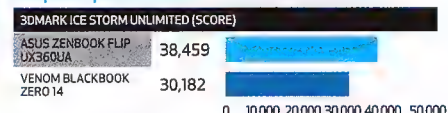
General system performance



Battery life



Graphics performance



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A high-quality and solidly-built ultraportable with good but not quite great performance and value.



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No.1 Gaming Graphics Card Brand

[EPIC]



ASUS GeForce[®] GTX 1080 Ti

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VR
READY

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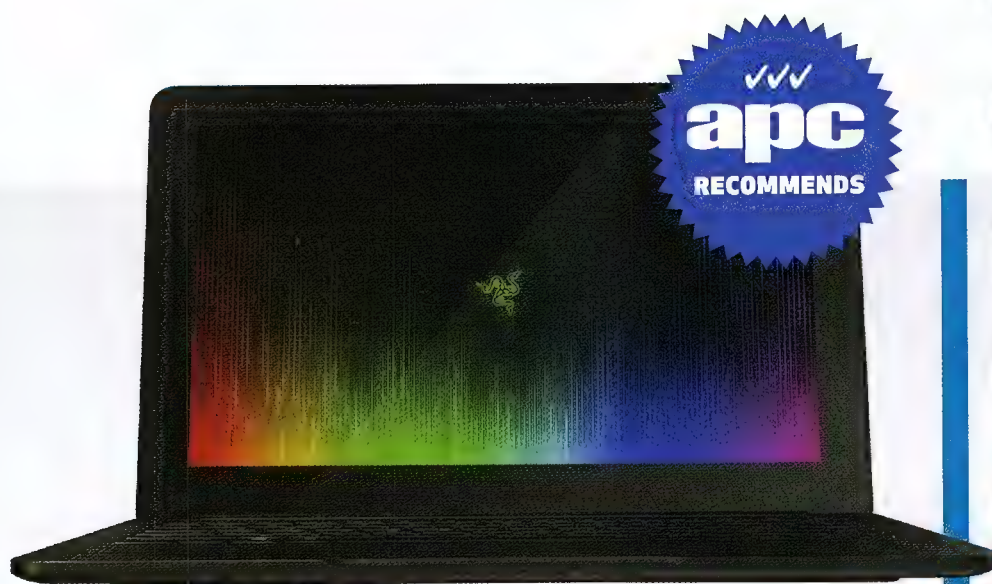
TURBO

- Ultimate Cooling**
- Dual-ball Bearing Fan
 - Vapor Chamber
- Premium Quality**
- Auto-Extreme Technology
- Best Gaming**
- VR-friendly HDMI Ports
 - Customizable Backlit Logo



ROG STRIX

- Ultimate Cooling**
- MaxContact Technology
 - Patented Wing-blade IP5X Fans
 - ASUS FanConnect II
- Premium Quality**
- Auto-Extreme Technology
- Best Gaming**
- VR-friendly HDMI Ports
 - ASUS Aura Sync



GAMING LAPTOP

FROM \$1,499 | WWW.RAZERZONE.COM

Razer Blade Stealth (2017)

A rather stealthy upgrade.

With its original Blade Stealth, Razer delivered an impressive ultrabook with a whole lot of style and an affordable price tag to go with it. Now, the American gaming hardware-maker has returned with an update that largely provides more of the same, albeit with a few notable improvements.

Its processor has been seen a generation bump, going from an Intel Core i7-6500U to the more energy-efficient i7-7500U. You'll also find that the new Stealth now offers 16GB of memory as an option (up from last year's 8GB), alongside PCIe SSD storage up to 1TB. It's also got a larger battery which promises a 15% higher capacity. While the previous Stealth had a 3.25hr battery life under intense usage, the new Stealth kept on trucking for a full half hour longer. When subjected to constant 1080p video playback at 50%

brightness, the Stealth lasted 5 hours and 42 minutes, putting it directly in line with the Acer Swift 7 laptop (issue 439, page 20) – a welcome improvement.

Like the previous Stealth, this updated version isn't really aimed at gamers, though it can still be used in conjunction with the Razer Core peripheral, an external enclosure that lets you plug in and use a desktop graphics card via the Stealth's Thunderbolt port. That said, even without the Core, the Stealth still outclassed many of its ultrabook competitors in our 3DMark tests, but it's still a long way behind dedicated gaming laptops.

In terms of build quality, the new Stealth is nearly identical to the version that released last year, with a beautiful (and durable) CNC aluminium body that sports Razer's signature matte-black finish and light-up green logo. With a thickness of only 13.1mm, the Stealth

is around 4mm thinner than the MacBook Air, which Razer sees as its main competition. The company's signature Chroma keyboard LED backlighting is also included, letting you customise colours, with 16.8-million options per key, so you can personalise your keyboard lighting effects in any way you like.

The new Stealth packs the same impressive 1440p IGZO touchscreen display as its predecessor, offering 100% RGB colour coverage and 150-nit display brightness, though regrettably, it's still hampered by an unusually wide bezel that keeps the device's screen size at 12.5-inches. It's also available with a 4K display, though we'd expect that version to eat through the battery at a quicker rate.

As before, we would've loved to have seen this bezel reduced and the display bumped up to a MacBook Air-matching 13-inches. As it

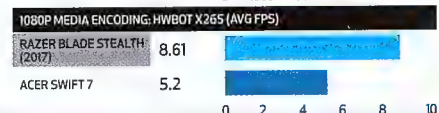
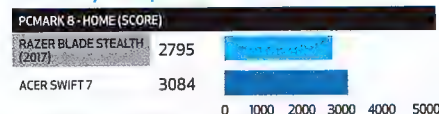
stands, it's the one visual aspect of the Razer Blade Stealth that feels dated, despite the rest of the unit looking utterly gorgeous and cutting-edge from a design standpoint.

Regardless, given its wonderful QHD touch display, impressive specs, stylish design and solid build quality, at a starting price of \$1,499 (\$50 less than a bottom-tier MacBook Air), the Razer Blade Stealth is still an absolute steal if you're shopping for a Windows ultrabook.

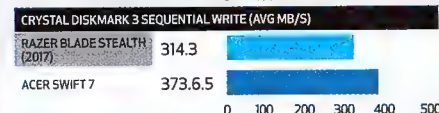
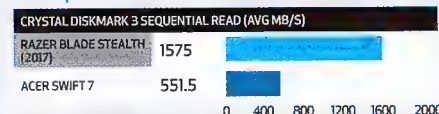
■ Stephen Lambrechts

LABS BENCHMARK RESULTS

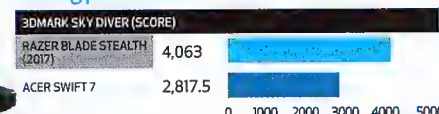
General system performance



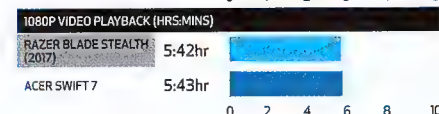
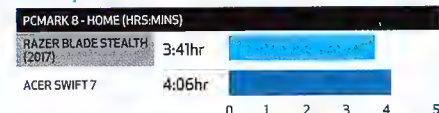
Disk speed



Gaming performance



Battery life



Verdict



An improvement on the previous generation, but that 12.5-inch screen stops this Blade from gleaming.





2-IN-1

\$1,499 | WWW.ASUS.COM/AU

ASUS ZenBook Flip UX360UA

Flipping a new leaf on 2-in-1 laptops.

Just a glance at ASUS's refined ZenBook Flip UX360UA is enough to betray the notion that the 2-in-1 category has matured. Made up of two 14mm polished aluminium halves, the Flip is fused together by a pair of honed, fully reversible hinges that allow the screen to fold completely back on itself.

Striking the perfect kinetic balance between consistent movement and a secure hold, this hybrid's screen-to-keyboard weighting lets you tilt the screen without having to hold the base. This makes it feel first and foremost like an uncompromising day-to-day laptop – something that can't be said for many 2-in-1s on the market.

The Intel Core i5-6200U CPU, 256GB SanDisk SSD and 57Wh battery allow the Flip to maintain a sprightly 1.27kg physique, which also makes it surprisingly usable as a high powered tablet.

Although it's lightweight, the Flip hasn't skimped on the build quality: the

polished aluminium chassis looks sophisticated, feels elegant and provides a sturdy and resilient frame.

There's an obvious amount of engineering finesse in the silky trackpad and the nicely weighted keyboard, which work well together and make this unit function admirably as a highly-desirable laptop.

We're not overly fond of the power button's relocation to the left edge of the unit, but compromises are necessary in 2-in-1 devices.

The higher-end ZenBook Flip model with a quad HD screen wasn't available in Australia at the time of writing, but the 1080p 13-inch touchscreen on our test unit still had an exceptionally crisp image and we wonder if the higher-end model's display quality would be worth the resulting compromise in overall processing power. Backing up that nice 1080p screen is a partnership with Harmon Kardon that has resulted in an exceptional quality stereo speaker setup, which can blast best-in-class

audio; however, their downward-firing design works poorly on plush surfaces or when you've got the keyboard flipped around and facing down.

Fitted with a SATA 6Gbps-connected SSD, the Flip gets pretty standard 521MB per second sequential read and 343MB sequential write speeds. For general home usage and work benchmarks in PCMark 8, the Flip netted scores of 3,003 and 4,210, respectively, in line with other devices in this class. When it comes to multimedia work however, the ASUS's Intel Core i5-6200U SOC (including integrated Intel HD Graphics 520) outperforms the Venom and Acer's seventh-gen Core M chips, with multithreaded CPU CineBench scores of 268 and 37.9fps in OpenGL rendering. Those two competing units feature Intel Core i5-7Y54 and i7-7Y75 packages, which managed to only net respective scores of 174/25fps and 204/30fps.

Considering you get more than 6 hours across both of PCMark's demanding battery life benchmarks, we're very impressed with the overall performance.

A surprisingly ample suite of connectivity options that includes two USB 3.0 connections, an HDMI input, USB Type-C port, SD Card reader and a 3.5mm headset jack further sweetens the deal. When you can get it for \$1,500 (between \$200 and \$500 less than equivalent offerings), we're at a loss to think of any reason why this wouldn't be your first choice if you're looking for an affordable 2-in-1.

Joel Burgess

Verdict

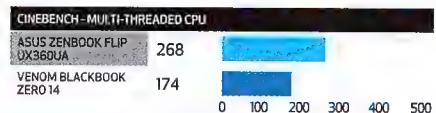
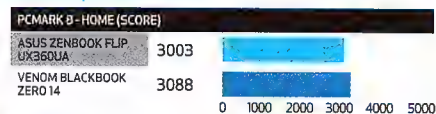
Features ★★★★★
Performance ★★★★★
Value ★★★★★

Combines respectable performance, great battery life and a first-class build quality at a very fair price.

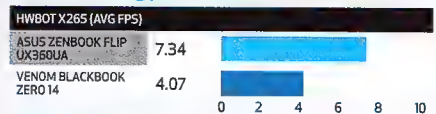


LABS BENCHMARK RESULTS

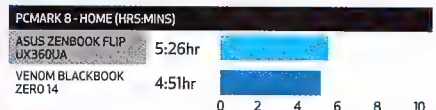
General performance



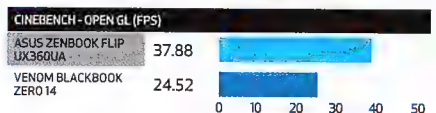
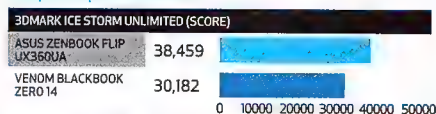
Media encoding performance



Battery life



Graphics performance





ALL-IN-ONE GAMING PC

FROM \$1,499; AS TESTED, \$2,799 | WWW.PIONEERCOMPUTERS.COM.AU

Pioneer Computers DreamVision 32-inch AIO Gaming PC 7X

A true gaming all-in-one PC, but does the dream live up to the vision?

We were excited to test Pioneer Computers' 32-inch gaming PC, predominantly because we've never seen an all-in-one (AIO) that also manages to pack in a full gaming rig around the back – which gives you full access to swap out components right up to the motherboard itself. However, weighing in at a hefty 30.6kg, this PC is an absolute beast.

Between the oversized screen, the small detachable feet that need to be screwed on and the shortish power cable, it's a bit of a work out to get this machine set up. You'll need a spacious and sturdy desk to sit it on, since the massive screen wears its PC on its back, meaning the it has a cumbersome depth of 18cm (25cm, if you add the full expanse of the feet). We have to say that, even when set up on a sufficiently roomy desk, the 1080p 32-inch display is almost too

large to use as a general PC screen. Windows scales the icons and taskbar contents to a childish-large size, and for any general web browsing or work tasks, the top third of the screen sits outside your natural peripheral vision (unless you sit 3–4 feet back), rendering it largely useless.

The powerful Intel Core i7-7700K CPU inside did a good job of bulldozing through general home and work related tasks. Very high PCMark 8 scores of 5,165 and 5,608 in the respective accelerated Home and Work tests are backed up by one of our highest (labs-recorded) scores of 959 on Cinebench's multi-threaded CPU benchmark. Add to this a generous 512GB SSD connected via PCIe that can read sequential data at 1325MB/s and write it at 584MB/s and you have an unusually overpowered work PC.

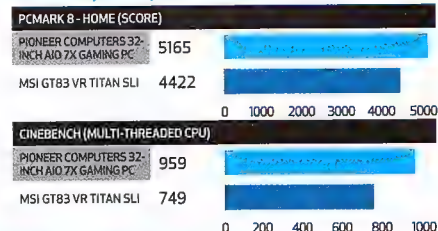
It's also fairly good at gaming, too. The PC's 6GB desktop Nvidia GeForce GTX 1060 GPU managed a Fire Strike Extreme score of 6,004, breezing past Gigabyte's similarly specced P55W v6 laptop (issue 436, page 47), which scored 4,942, though it remained some way off MSI's GT83VR Titan SLI rig (435, page 24), which used its two GTX 1080 GPUs in SLI to pull the ludicrous score of 13,921.

Testing real-world games was equally rewarding, pegging averages of 62fps in *The Division's* challenging benchmark on Ultra/1080p settings. This stands up nicely against the Gigabyte P55W v6's score of 49.8fps and the MSI GT83VR's score of 60.2. The DreamVision ploughs through older titles like *Metro: Last Light* and *Tomb Raider*, achieving averages of 91 and 162fps on 1080p/Ultra settings, almost keeping up with the GT83VR's 113 and 198fps.

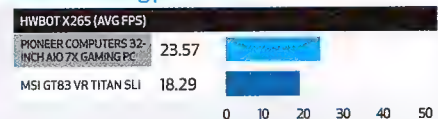
We were initially afraid that this AIO's large screen wasn't ideal as a general-purpose PC, but most of those concerns were abated when we saw games running on it. If you have the cash to splash on a dedicated gaming rig, then this massive-screened all-in-one is undoubtedly an option worth considering – although with a little research and some elbow grease, you'd be able to piece together a similarly sized rig with equivalent performance without much difficulty, albeit not one in this single-piece package. ■ Joel Burgess

LABS BENCHMARK RESULTS

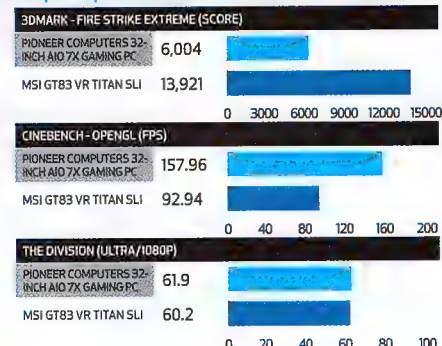
General system performance



Media encoding performance



Graphics performance



Verdict

Features
Performance
Value



This plugs a genuine set of desktop components into a bloody big screen, but not ideal for all-purpose computing.





GAMING MONITOR

\$899 | WWW.ASUS.COM/AU

ASUS RoG PG258Q

This one's got a refresh-rate so high it almost hertz.

ASUS's RoG PG258Q has a very specific target audience: the hardcore, competitive gaming crowd. Take a quick glance at the core specs and it's easy to understand why. Packaged in a 24.5-inch form factor, the PG258Q has a 1080p native resolution with a wide-screen 16:9 aspect ratio – the preferred form and pixel count for pro gaming. That isn't what'll make the target market drool, however, and neither is it the inclusion of G-Sync. No, it's the ludicrous 240Hz refresh rate paired with a minimum response time of 1ms. For the twitch-shooter crowd and racing buffs, these two spec details are enviable – although they'll require significant GPU grunt to reach that desired 240fps.

It presents well with thin panel bezels, unique back panel design elements, a striking three-pronged stand and a customisable projection lighting feature built into the unit's stand.

These ingredients don't just make for a desirable display from a specifications perspective, but also a visually intriguing setup that's pleasing both technically and aesthetically.

The panel needs to be fed by a DisplayPort 1.2 connection to reach the impressive refresh rate frequency, with the HDMI 1.4 port restricted to a maximum of 60Hz. It's important to bear this in mind when considering the supporting hardware to feed this display and how you wish you connect it, as an HDMI setup will leave you spending money for features you can't use due to HDMI 1.4 bandwidth restrictions.

For users considering this display as an all-rounder, be mindful that the colour reproduction isn't great. Sure, the display touts 100% sRGB colour gamut coverage, though this is a fairly universal spec in the modern monitor market. Featuring a 6-bit TN panel

with frame rate control (FRC), the PG258Q still technically delivers an 8-bit colour range with the 6-bit + FRC combo helping to achieve the performance specs. Also, in terms of colour reproduction, if this matters to you, don't bother straying from the sRGB preset, as alternate presets like Cinema and FPS, among others, blow out different colour elements such as gamma, contrast and brightness, leading to banding and washed out blacks.

Joining the DisplayPort 1.2 and HDMI 1.4 ports is an integrated USB 3.0 hub with one upstream link and two downstream links. It's nice to have this level of support; however, functionally there are conflicting design choices in terms of the implementation. The choice to integrate a USB 3.0 hub is a little undermined by the fact that the ports are completely covered by the rear I/O shield and are, therefore, a bother to access – and easy-access is

generally what you're looking for in monitor USB ports. If you're looking for a user-friendly monitor based USB hub, this display's implementation will leave you wanting.

Featuring the best OSD navigation on the market paired with a clear and concise OSD layout, switching settings is a breeze. Noting the gamer-focused features in the 'GamePlus Technology' suite, such as FPS counter and session timer, the PG258Q is ready to game.

But beware, in this case you'll certainly be paying to play!

■ Josh Collins

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

The experience is second to none in fast paced action. But colour reproduction is poor.





GAMING MONITOR

\$899 | WWW.VIEWSONIC.COM.AU

ViewSonic XG2703-GS

Watch out ASUS, ViewSonic is gunning for you.

Thanks to the aggressive prices of the latest UHD TVs, the value proposition of any given PC monitor is currently pretty parlous. Take the new ViewSonic XG2703-GS. For around \$900, you get a paltry 27-inches of LCD panel and a mere 2,560 by 1,440 pixels.

Over in UHD TV land, the astonishing reality is that \$500 will buy you 40-inches and the full 4K complement of 3,840 by 2,160 pixels. So that's nigh on one third the money for roughly twice the screen by the major metrics.

Of course, UHD TVs are not directly comparable with PC monitors. What's more, ViewSonic's latest, looks pretty clever next to what is arguably its nemesis, the ASUS RoG Swift PG279Q. Both monitors tick an awful lot of the same boxes. We're talking 27-inch, WQHD resolution, IPS panel technology, 165Hz refresh capability and support for Nvidia's G-Sync adaptive frame syncing tech. And yet

the new XG2703-GS comes in at a full \$290 cheaper than its ASUS competition.

ViewSonic has done a very nice job with its latest gaming panel. The colours really pop, without being over saturated and both the black and white scales are pretty much pitch perfect.

As you'd expect for an IPS panel, the viewing angles are superb. More of a surprise are the deep and inky black tones. Contrast performance is above the IPS norm. We really like the smooth, clean anti-glare coating, too. There's hardly a whiff of that nasty grain and sparkle that blighted those IPS monitors of yore.

Support for up to 165Hz refresh just sweetens the deal, as does the lack of perceptible input lag and G-Sync doing its thing in games. Add that to those rockin' colours, the clean panel coating, the top-notch viewing angles, the super-smooth rendering and you have a near faultless package. The chassis is also a nice break from the norm,

and comes complete with some slick plastics and green accents that hint at the Nvidia G-Sync tech inside. The stand is fully adjustable, to boot, including rotation into portrait mode.

If you were determined to find fault, a little banding is visible in gradients and the black levels can't quite compete with the very best VA panels. Likewise, the 165Hz refresh setting is buried under a very silly 'overclocking' heading in the on-screen menu. And the ASUS Swift is superficially a bit snazzier as a piece of consumer electronics. That aside, there's virtually nothing in it.

With all that in mind, we're certainly struggling to come up with compelling reasons to pay the extra \$290 for the ASUS option. But still, that UHD TV comparison is hard to shake. Indeed, there are some 40-inch 4K PC monitors, albeit somewhat UHD TV derived, that come in well under the price of this panel. Heck, there are middle-

budget smartphones that can match its pixel count.

The inclusion of G-Sync, requiring a proprietary module inside the monitor, adds at least \$290 to the retail price, as do the refresh capability and the quality IPS panel — industry-wide issues, not things specific to this monitor, of course.

But \$899 still feels like one hell of a lot for a 27-inch PC monitor with mere WQHD resolution. Hopefully the market as a whole will realise this sooner rather than later and the price of this kind of high-performance 27-incher will come off a little. It needs to.

■ Jeremy Laird

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Awesome IPS panel; outstanding all-round image quality, with a superb feature set — but you'll pay for it.





MECHANICAL GAMING KEYBOARD

FROM \$160 | WWW.ROCCAT.ORG/EN-AU

MECHANICAL GAMING KEYBOARD

\$350 | WWW.CORSAIR.COM

Roccat Suora FX

A colourful and simple mechanical gaming board.

This mechanical gaming keyboard might look familiar, and true, we did review its older brother back in August 2016 (page 38). So what's changed, apart from the 'FX' appendage in the name?

Fans of the original will be pleased to know that Roccat has only added features to its second Suora-named keyboard. The keys themselves are pleasantly concave – except the spacebar, which is smoothly convex – and the frameless design of the full-sized 'board means there's no wasted material here.

It boasts the same aluminium alloy base as the original and, in Australia, it's only available with Cherry Blue switches, which we found to be very clacky; they are loud, love them or hate them. Due to the nature of the floating key design, however, the newly added RGB lighting is quite bright and leaks out from under the keys, which may prove slightly distracting.

With the original Suora, the lighting was limited to fluoro blue, but you've now been given the full rainbow to play with. The F1–4 keys offer different effects, such as breathing, wave, solid and ripple, which are truly stunning to look at, though questionably useful in real-world situations.

The keyboard features 1,000Hz polling, N-key rollover, six macro keys, media controls and that ever-handy Game Mode button, which launches custom gaming profiles and disables the Windows key.

For a gamer who likes the minimalistic look and RGB, this keyboard can be found online for about \$160, but at time of writing, no brick and mortar shops stocked it.

■ Carmel Sealey

Verdict

Minimalistic, functional and stylish; with questionable practical uses for its new lighting effects.



Corsair K95 RGB Platinum

Gold-plated frames and every key topped with rubies and emeralds.

Corsair's K95 Platinum seems to have it all. For the price of a Radeon RX 480, you can get a mechanical keyboard with all the trimmings. Macro keys, Cherry MX Speed switches, RGB lighting, aircraft-grade brushed anodised aluminium, 8MB of storage for swappable profiles, a detachable, double-sided wrist rest, a proper (ie. not 'charge-only') USB port, a USB cable and a metal rolling volume control.

Its edgeless design means the keys stand out proudly from the baseplate and you can inspect their undersides like an over-friendly drill sergeant. The drawback to this kind of design is that it mercilessly exposes grot and crumbs. The caps are easily removed for cleaning, though. The light touch needed on the MX Speeds, mixed with the weightiness of the keyboard base, mean it's a board that lends itself to quick use and would make a fine first 'board.

All the Platinum's keys are programmable, but the dedicated macro keys, on the right, are distinguished by a different colour and texture. Not content with every key (except for the macro keys) having RGB LEDs underneath, Corsair has run a strip of lighting round the back and top edges of the keyboard, too. This requires programming, of course, and duties are held by Corsair's Utility Engine software.

There's not much to criticise here – except that mandible-slackening price. The original K95 with the same switches goes for around \$50 less, the K70 Rapidfire knocks even more off, and the HyperX Alloy is literally half the price.

■ Ian Evenden

Verdict

Well made, fully featured and a joy to use, but that price will certainly put some off.





GAMING MOUSE

\$139 | WWW.RAZERZONE.COM/AU-EN

Razer Naga Epic Chroma

Pretty and wireless, but for MMOs only.

Back in our June 2016 issue, we did a roundup of gaming mice including this Naga's older brother, the Naga MMO. Sporting an 8,200dpi laser sensor and 19 buttons, this new 'Epic Chroma' variation is a mouse for MMO players, just like its predecessor.

The design hasn't changed a great deal between iterations – it's still a large mouse suited for palm grippers. Those 12 buttons consist of the usual left and right clickers, a scroll wheel that clicks in three different ways, two buttons sitting vertically below the scroll wheel and then the 12 thumb buttons. While 12 buttons might sound like a minefield in terms of navigating your thumb to the right one in the middle of a fight, the buttons have actually been designed with their own unique angles, so that it's easier to find each without looking.

The titular feature of this peripheral is, of course, the RGB lighting. Customised through Razer's Synapse 2.0

software, you can control the backlighting on the thumb keys and the scroll wheel, as well as set up multiple profiles and manage your key bindings.

Another new feature for the Epic Chroma is its wireless capability. The charging dock doubles as the receiver and works well up to about 3m away, so this mouse can easily be used for couch gaming. But is this the mouse for you? The Naga MMO can be found for about \$89. Whether the added wireless versatility and colour customisation is worth the extra \$50 will depend on your personal preference. One word of advice, though; don't buy this from the official site, as you'll end up paying twice the price. ■ Carmel Sealey

Verdict

A large wireless MMO mouse for righties only, with wired option, pretty colours and high price.



GAMING HEADSET

\$170 | WWW.LOGITECH.COM

Logitech G533 Wireless

Tireless wireless.

While there's a lot to absolutely adore about Logitech's wireless G533 headset, there's also a few things you'll need to endure.

Closed-back ear cups are a bit of a science to get right. These wobbly, 30°-ish twisters should clamp down on a head of any shape. But we found an element of looseness. The fabric is a rather rough mesh, fully washable, but we found it massively itchy.

The microphone is cool in its design, clicking up flush with the right ear cup to mute itself and a dim, subtle red light to indicate when it's muted. But the mic itself isn't sensitive enough to satisfyingly pick up anything below an almost-shout, but when it's near your mouth, it's buzzy, clipping, overpowered.

Audibly, it's a clear, untouched sound stage with none of the infighting you might find in other headsets, even at very high volumes. The software DTS

7.1 surround sound is fine, and every frequency gets the same chance to shine. You're free to tweak your own equalisation and set up personalised profiles on a per-game or per-program basis. And you're free to enjoy all this within a decent range of its simple USB dongle, with such little lag that it's completely imperceptible.

We got 15 hours battery life from a full charge at a reasonable listening volume here, and the automatic power-off makes sure the G533 should be ready when you need it. There are no jack options and, since it runs a proprietary lossless wireless protocol, the G533 is tied to your PC, but it's a decent set, all in all.

■ Alex Cox

Verdict

Clean sound, great battery, decent range, software flexibility.





VIDEO CAPTURE DEVICE

\$269 | ELGATO.COM

Elgato Game Capture HD60 S

Boost your gaming broadcasts.

The HD60 S looks and works almost exactly like its HD60 predecessor. It takes an HDMI input from a game console, for example, and passes it through to a TV (with no latency that we could detect) and also over USB to its app on your Mac. There you can record it or broadcast live – with optional overlays and a voiceover – to services such as Twitch and Ustream.

Its key feature is Instant Gameview. This reduces the latency seen in the preview on your Mac from the two to three seconds that previous models suffered to a tiny duration. This isn't designed so you can play on your Mac's screen, but to make life easier and your broadcasts potentially more professional by reducing the disconnect between screen and stream.

The need a fourth-generation or better Core i5 processor and an AMD or Nvidia GPU may exclude

your Mac from compatibility; it worked well on our MacBook Pro, though even that couldn't deal with the app's 60fps preview. Note that the frame rate on recordings is unaffected by this.

The design is streamlined and the case is exactly the same dimensions as the HD60, as is its weight. Other similarities include the recording limitations – the HD60 S can only record at up to 40Mbps, whereas the HD60 Pro can manage up to 60Mbps.

The software is pretty easy to use, too, and should be familiar to those who are upgrading from the HD60.

All up, it works well; however, there are cheaper options out there.

■ Alan Stonebridge

Verdict

A good tool if you're serious about broadcasting your gaming.



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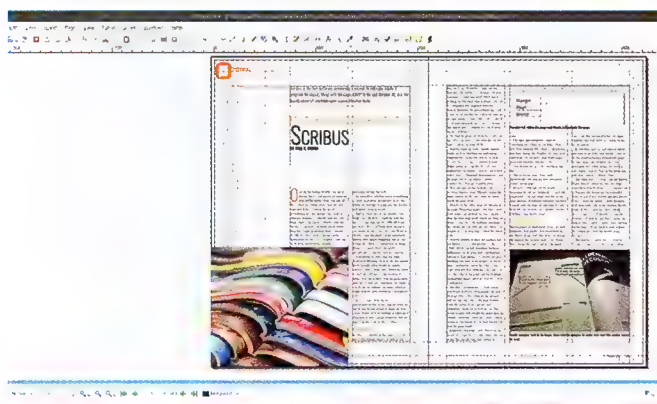
There are stacks of open-source programs for word processing and other office tasks, but what about the big daddy of computer publishing — the desktop publishing app?

Say hello to Scribus, which has high-end features without the high-end price tag. Or any price tag, come to think of it. Scribus is a piece of open-source desktop publishing software that is completely free (even for commercial usage).

This impressively in-depth software offers professional page layout capabilities, works with both XML and OpenDocument formats including Word and PDF, and can be used with most languages. Scribus is also available across multiple platforms and can be used to lay out everything from business cards through to newsletters or brochures.

The user interface is clean and easy to use. You begin with a blank slate of workspace, called the document, and into this, you can place objects, the majority of which are frames. Text frames carry your written content, image frames are for pictures, and there are other shape/line frames to make fancy graphics with (graphs and pie charts can be inserted, for example).

Once you lay all these frames down, you can then resize or shift things about, adjusting text and image frames



so everything looks good. You can add your own fonts quickly and easily, and work with scripts using premade scripts to do things like automatically enlarge an object to the full size of a page.

Scribus has been in constant development for 13 years and its powers include professional typesetting and colour management (but not Pantone colours due to licensing, although you can add Pantone yourself), as well as online publications such as interactive forms and PDFs.

It's worth noting that, if you do get stuck with the program, there's a sizeable community on hand to help via a mailing list, IRC channel and Wiki page (the latter is very informative with plenty of tutorials).

Scribus is available on more than just Windows — you'll also find it on macOS, Linux and a number of other more obscure operating systems.

Cat Ellis & Gary Marshall

Kindle for PC

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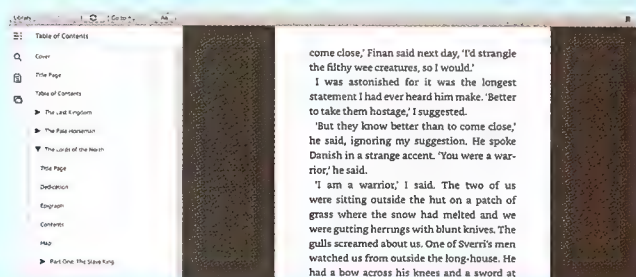
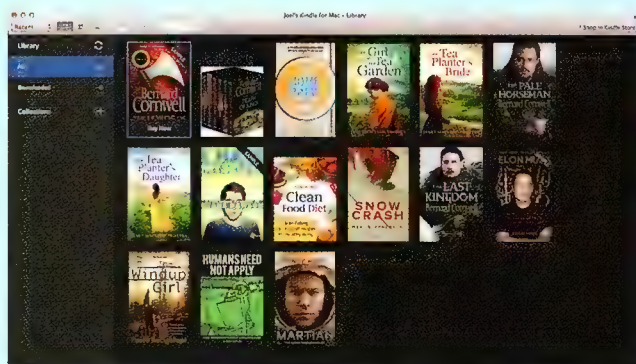


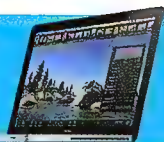
Whether you use Amazon or not to acquire ebooks, Kindle for PC is the best free reader for your digital collection. Amazon's official Kindle for PC ebook reader is smart and stylish — and although it tempts you with reading suggestions from the Kindle Store, you're able to fill your library with any book in the DRM-free MOBI ebook file format.

With Kindle for PC you can easily manage your virtual library, read books and buy new ones through Amazon. Just log in with your usual Amazon account details and the software will automatically sync with all your other Kindle devices and apps, including bookmarks and notes. Despite notes, bookmarks and flashcards (an extremely useful addition for students) being synced across devices, you'll have to click a book's cover to download it — something to bear in mind if you're planning to read offline.

Kindle for Windows also includes text-to-speech function, and changing font sizes and color schemes is as simple as clicking or tapping a button.

Cat Ellis





Mac » APPS

Photolemur

Photo editing and AI combine.

\$46.99 | PHOTOLEMUR.COM



Photolemur is a photo editor with a difference: it uses subject recognition and applies adjustments automatically. Rather than applying specific filters or fixes, it identifies features such as faces, trees, skies and landscapes to make enhancements that are specific to the subject and image. What's more, it learns as it goes, so should get better the more it's used.

Photolemur looks at image colours, exposure, contrast and white balance, and analyses an image on a pixel-by-pixel basis before making adjustments to enhance each shot individually. If you save an image, it's added to the 'success' list, but if you don't, it's added to the 'blacklist', thus helping Photolemur learn what you like to see.

Photolemur couldn't be easier to use. Click 'Load Photo' to upload an image or a selection of images, or drag a collection of files to the main screen. It then starts processing the images before revealing the first image, with a line dividing it into before and after views. You can drag the line left or right to reveal more or less of the adjusted version. A sliding control under the preview lets you alter the adjustment on a scale from Realistic to Vivid. In most cases, we found the default effect was fine, but it's nice to be able to make a tweak occasionally. The only other control is a crop/rotate tool accessed via the scissors icon. This can be used as a click-and-drag tool, but you can also enter a specific angle of rotation if you like. It's also possible to set an aspect ratio



for the crop. If you upload more than one image, the unopened images are visible in the collapsible browser bar underneath the central preview screen. Simply click any of the images to see the adjusted version.

Photolemur is extremely easy to use and works very well, with a variety of adjustments applied to varying degrees to different images. In some cases, the adjustment can be very subtle, whereas other images may have a more dramatic edit applied. It works especially well with dull or dark images, bringing them to life by brightening them selectively, boosting the local contrast to bring out details and increasing colour saturation.

The bottom line is, Photolemur is very easy to use and it successfully enhances a wide variety of images automatically. **Angela Nicholson**

Pastebot

Infinite clipboards for your Mac.

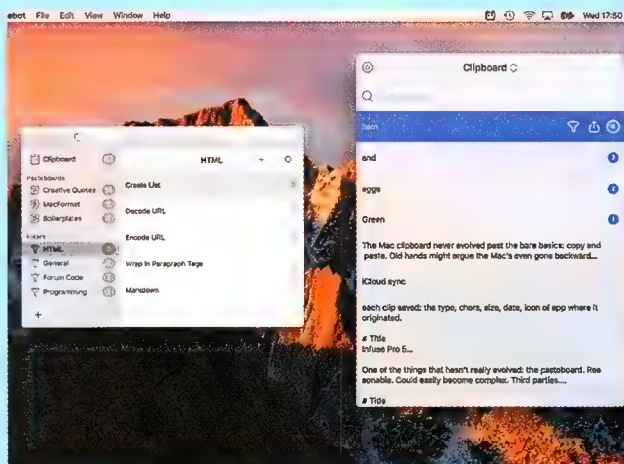
\$14.99 | TAPBOTS.COM/PASTEBOT

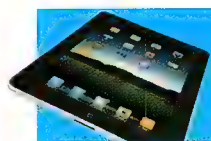


At its most basic, Pastebot is a massive clipboard, holding up to 1,000 clippings. You can ignore copies over a certain size, sync clippings over iCloud, and easily get at them using a Quick Paste window invoked using Command-Shift-V. The most recent 10 copies can be pasted using number keys; or you can navigate using cursor keys or the mouse, and can delve deep into your clipboard history using the window's search field. This proves responsive and reliable, but it's arguably elsewhere that Pastebot's real magic happens. The main window lists data for each clip — origin, size, date and so on — and you can search by these criteria. Favourites can be stored as custom clipping sets, and again accessed using shortcuts.

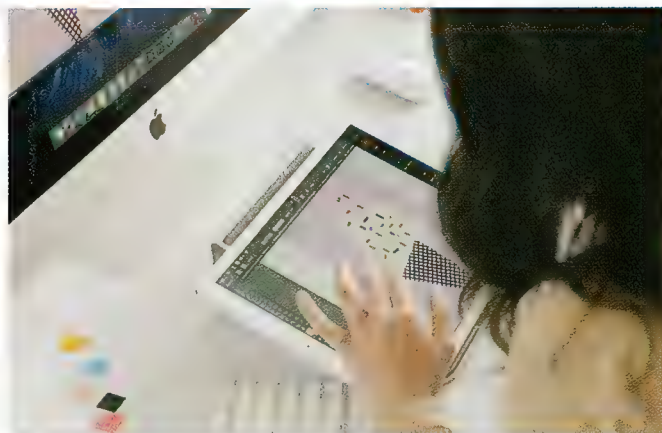
Best of all are the filters, which rework copied text; for example, changing its case or transforming words into an HTML list. Several are included, but you can also make your own. In the right hands, these filters make Pastebot hugely powerful, but even when just using the basics, it's well worth the outlay.

This is a utility that should appeal and prove useful to the widest range of Mac users. **Craig Grannell**





App Store » iOS APPS



Astropad Studio

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ASTROPAD.COM



In a nutshell, Astropad links your iPad and Mac together: the iPad displays whatever program you're running on your Mac, and whatever you draw with a stylus on your iPad appears on your Mac. Last year's Astropad Standard app enabled you to do this with a variety of iPad models and any stylus you owned. Studio, however, works only with iPad Pro and Apple's Pencil. Another important difference is that Studio is only available through a monthly or annual subscription, managed through an online account.

It's clear that Studio is a professional solution, aimed at working artists and designers who expect to be drawing for hours every day. Setting everything up is a chore, simply because of the number of components you're working with. First, create your Astropad Studio account and set up your subscription. Next, download and install the Astropad app on your Mac and the Astropad Studio app on your iPad Pro. Now run both apps: as long as your Mac and your tablet are on the same network, they'll recognise each other and your Mac screen will be reproduced on your iPad Pro.

The combination works well in practice. If you link your iPad and Mac with your iPad charging cable, the connection between the two screens feels instantaneous. If you decouple the iPad and link through Wi-Fi instead, you might notice a bit of lag between the Mac screen changing and the iPad screen updating, depending on the speed of your wireless network. We were never excessively bothered by the time lag, though.

The exclusive use of iPad Pro and Pencil means that Astropad Studio has several extra features compared with Standard. For example, Studio's Magic Gestures feature enables you to combine finger tap and Pencil gestures to trigger responses, including simulating a right-click or switching between tools.

This app is state of the art, but you might prefer the Standard edition's pricing if you're a more casual sketcher.
Richard Hill

DoTalk

Multilingual chatting.

FREE WITH IAP | DOTALK.COM



DoTalk is a simple translation chat app created by an Aussie that's attempting to break down language barriers one translated chat at a time.

Download, create a profile, choose your native tongue out of a choice of 90, find some contacts to add to your list of friends from anywhere in the world, then chat away. You can either type or dictate your conversations in your chosen language and the app's proprietary technology — APIs and speech recognition — will send a translation in your recipient's chosen language.

We tried English, German and Hindi, and ran into a few spots of 'lost in translation' gibberish and more than a few hilarious moments. But for the most part, the gist was there. The microphone is pretty good, though. It picked up most of the Hindi sentences, bar a few words here and there.

It's definitely not the next WhatsApp, but the idea behind DoTalk is fantastic, and once the little glitches are ironed out, this technology could go a long way. Sharmishta Sarkar



MultiTimer

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FREE; PRO VERSION \$7.99 | WWW.PERSAPPS.COM



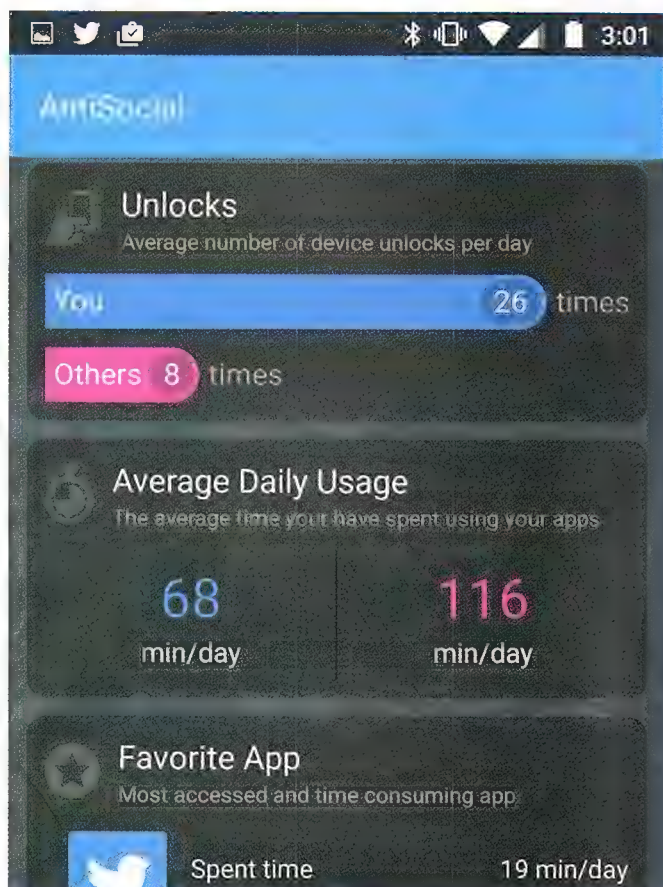
You're cooking potatoes that have to be in the oven for 45 minutes. The meat needs to slow cook for eight hours. The sauce needs to simmer for 15 minutes. You could do some mental backflips to figure out how to time all this, or you could download MultiTimer, set all these timers up in advance and hit go.

It's a super clean interface, meaning it's easy to find what you're looking for and discover what everything does without any sort of tutorial. You can colour-code each timer to your own personal taste (although, you will need to upgrade to the Pro version to access additional colours and other goodies), plus the timers can be labelled according to activities. You can count down, enable a stopwatch, time laps, start an interval timer (we hate doing those at training) and set up a pomodoro-style timer. You can also rearrange the order of your timers on the main app page and set the timers to display on your Today view. If you have to juggle multiple things at once, this app is invaluable. Carmel Sealey





Google Play » ANDROID



AntiSocial

Track your social media usage, then attempt to curb it.

FREE | ANTISOCIAL.IO



This Melbourne-developed app offers the slightly enervating but nonetheless useful convenience of tracking your social media usage. It does so, of course, in the name of measuring how addicted you are to Twitter or Facebook and helping you curb it. Once you've learned that you spend five more minutes per day than the average person browsing your friend's baby photos, maybe you'll take the initiative to stop. It doesn't just cover social media: you can track music listening, texting and more, with the app initiating a 14-day tracking period when installed in order to measure your general usage. Once that's done, the ability to blacklist certain phone features and apps will unlock, as well as time limits which shut apps down when exceeded. The stats and charts are quite granular, providing a to-the-second result for the amount of time spent in each app, as well as device unlocks. For example, between 8am and 9am in mid-February, I opened my phone five times (I'm addicted to GIFs of cats whipping dogs). Highly recommended if you love stats and hate wasting your precious time. **Shaun Prescott**

Flipboard

A fresh face for an old friend.

FREE WITH ADS | FLIPBOARD.COM



Flipboard has been around for a good long while now, but this new iteration is more gorgeous and more useful than ever. The concept remains the same — this is a magazine-esque app aiming to bring all your news together in one convenient package — but the app has shifted to a more customisable experience, allowing you to personalise your feeds with greater specificity. You now have the ability to subscribe to subheadings under broader topics, such as particular artists under the umbrella category of 'music', for instance, and each 'magazine' will then hone in further on your topic preferences. To accompany this, your home screen will feature up to nine of these chosen magazines to flick between, each offering a full-screen preview of the latest news and the ability to then scroll through their relevant stories. The home screen of old is still present, under the guise of 'cover stories', and is both unremovable and easily ignored. There are ads that pop up between pages (like a regular magazine!) as there doesn't seem to be a paid tier, but they're reasonably inoffensive and the sleek design and customisation is totally worth it. **Harry Domanski**

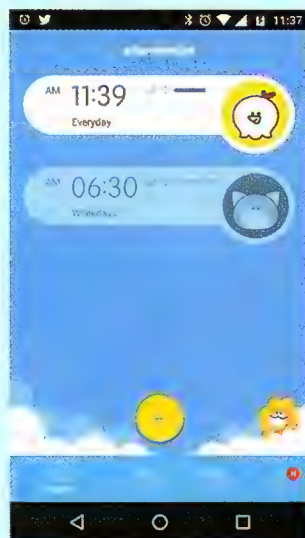
AlarmMon

Make waking up more obnoxious with cats and mini-games.

FREE | WWW.ALARMMON.COM



Unless you're a toddler yet to learn how grinding life actually is, waking up can be hard. Which is the problem AlarmMon addresses specifically, in particular: waking up is achievable, but how can we incentivise staying awake? Via 'celebrity' (or K-pop themed) alarm tones and mini-games, of course. This ad-supported alarm clock has a huge array of both free and paid alarm skins, ranging K-pop stings, cat screeches and alarms which require you to solve a times table question in order to switch it off. Which is cruel not only to yourself but to whomever might be lying next to you, especially if you can't add. It's possible to pay a fee (on top of the microtransaction skins) to create an ad-free experience in AlarmMon, and if you actually like the app, you'd be well-advised to do so, because having to swat away pop-ups first thing in the morning will bring about an early death. A decent novelty if you're, y'know, a bit "out there", but otherwise one for teenagers, probably. **Shaun Prescott**





Linux » OPEN-SOURCE SOFTWARE

QtPass

A password manager ideal for protecting your sensitives.

FREE | QTPASS.ORG

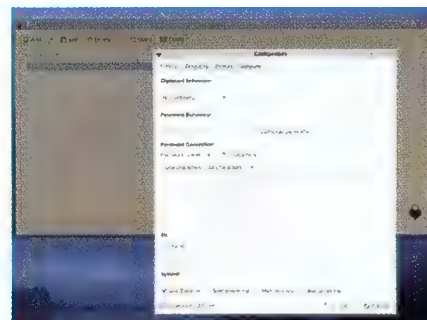
It's not that easy to learn all your different passwords by heart, especially if they need to be changed regularly, and that's why many security-aware Linux users turn to password managers. For those who don't like using a GUI-based manager, there's a powerful command-line utility called 'pass'.

The filename is the title of the website or resource that requires the password. These encrypted files can be organised into meaningful folder hierarchies, copied from computer to computer and, in general, manipulated using standard command-line file management utilities. But for those who like their GUIs, QtPass is a graphical front-end for pass that

helps avoid fiddling with the command-line arguments.

You need to add a user and generate a GnuPG keypair – simply provide an email, a nickname and a passphrase. You'll be taken to QtPass config window where you change clipboard behaviour, manage profiles and form templates.

The main application window resembles a customised note-taking manager or a bookmarks library. You can add an entry in order to store a URL, a password and a login name. (You change the default template to customise these fields.) Aside from root-level entries, you can create folders and subfolders, and then organise a custom hierarchy of your



password categories. QtPass supports multiple user accounts and enables you to set permissions for your password entries and folders – you can grant access to specific accounts and forbid other people from accessing certain passwords. This should not be confused with regular system-level Linux users, though.

QtPass is very flexible and is an ideal solution for protecting sensitive data where several users access the same Linux machine. It is also cross-platform, which is a massive plus.

Alexander Tolstoy

RawTherapee

A photo editor with lots of noise reduction tools.

FREE | RAWTHERAPEE.COM

This is a well-established tool for digital photography in Linux, especially for managing RAW files. The app's general aim is to make the best out of your camera's photos with more accurate colours, less noise, smoother skin tones and more. Gaining skills in restoring and enhancing RAW images means that you effectively learn to do it better than the automatic algorithm in your camera. RawTherapee also feels like a professional tool with its numerous sliders, graphs, preview panels and stylish grey icons in a dark-themed UI.

To learn our way around, we watched some video tutorials online. Some of the videos featured an older version of RawTherapee, which immediately highlighted how many extra options have been added to it. If you open an image and go to the Detail section, you'll see an abundance of noise reduction tools that cover lots of areas, including luminance/chrominance/impulse noise, defringe and contrast detail levels.

Any combination of custom settings in RawTherapee can be saved as a profile and re-used for another image or even for a batch of files. The application is already bundled with some popular profiles, such as the 'Default ISO High' profile for low-light images or the 'Non-Raw > Brighten' profile to fix an under-exposed JPEG.

RawTherapee 5.0 is the first major update in two years and there are lots of new tools for better handling different image defects. Apart from convenient noise removal, there are now different wavelet-based tools for fixing sharpness, the Retinex tool for fighting dust particles and restoring images that are too dark. The new version is a must-have tool for both amateur and pro users. Alexander Tolstoy

Neofetch

The Chosen One command-line tool?

FREE | BIT.LY/NEOFETCH

It's hard to find a Linux-related forum or discussion board where there isn't a popular 'Show your Desktop' thread. People love to show off their customisations to others and Neofetch is a little helper just for that. No, it doesn't take screenshots, but it does help you to quickly find out useful details about your system.

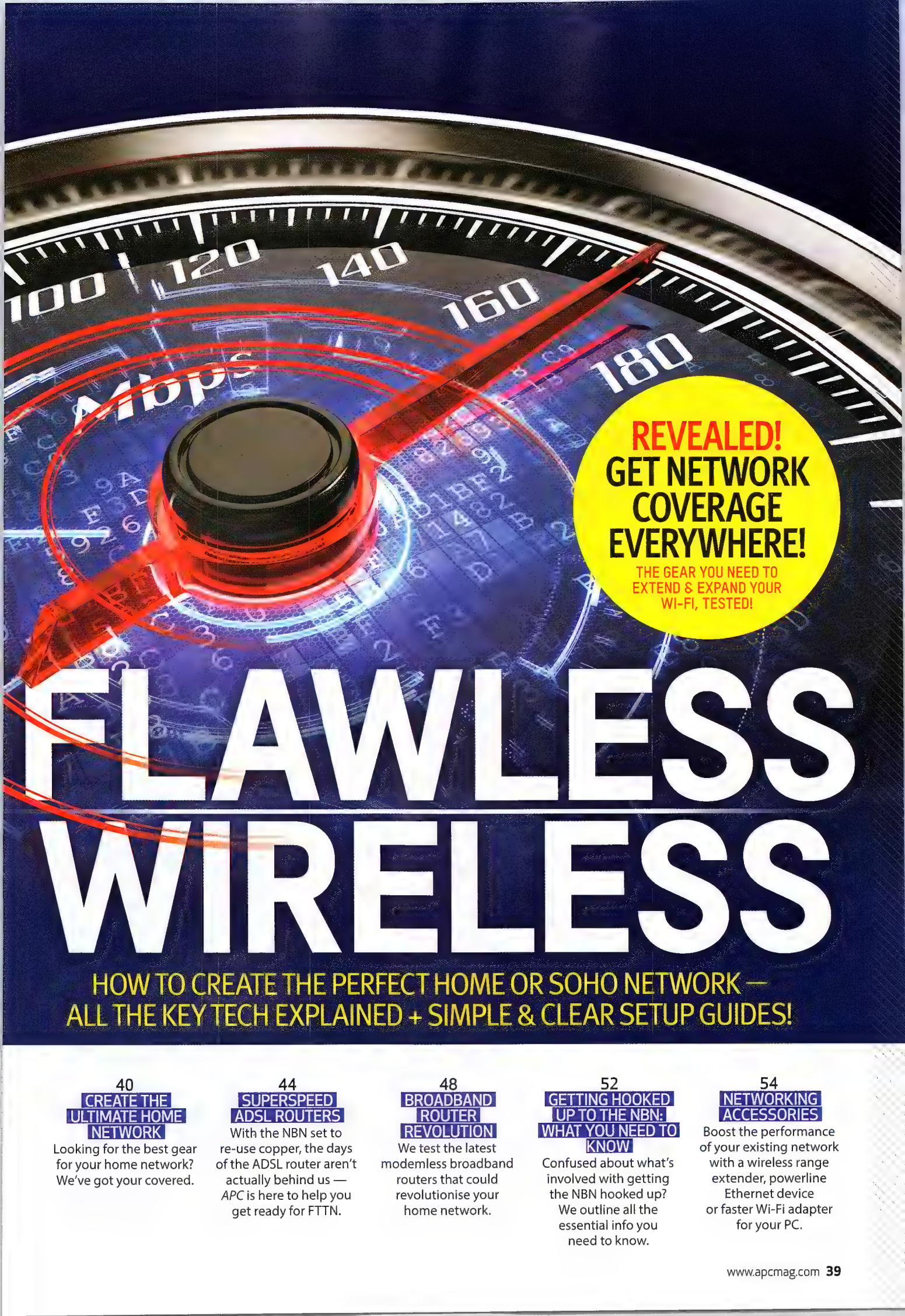
Using Neofetch, you can boast about your fantastic desktop and prevent a flood of questions such as 'What icon are you using for X?' Just run `neofetch` and you'll see a funny ASCII-rendered logo of your Linux distro (and 107 others) and a list of system details next to it.

In addition to extra ASCII artwork, this latest version allows you to enjoy CPU sensor output in Fahrenheit, multiple GPUs listed on different lines and fixed output in non-GTK-based desktop environments (so KDE users will no longer see GTK theme output listed in their screen fetch).

You can now configure Neofetch your way by modifying the `/etc/neofetch/config` file, which is a plain Bash script. This script enables you to comment out or add custom entries, and there are over 50 configuration options to play around with.

Installing Neofetch is very simple, as long as there are no binary components inside it. As usual, there's a special PPA for Ubuntu users at ppa:dawidd0811/neofetch, but there exists an even simpler installation method: you can clone/download the contents of Neofetch GitHub repos and just run `sudo make install`. If you like this small program, feel free to add it to your `~/.bashrc` file and enjoy it each time you open a terminal window.

Alexander Tolstoy



REVEALED!
**GET NETWORK
COVERAGE
EVERYWHERE!**

THE GEAR YOU NEED TO
EXTEND & EXPAND YOUR
WI-FI, TESTED!

FLAWLESS WIRELESS

HOW TO CREATE THE PERFECT HOME OR SOHO NETWORK —
ALL THE KEY TECH EXPLAINED + SIMPLE & CLEAR SETUP GUIDES!

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CREATE THE ULTIMATE HOME NETWORK

Looking for the best gear
for your home network?
We've got you covered.

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SUPERSPEED ADSL ROUTERS

With the NBN set to
re-use copper, the days
of the ADSL router aren't
actually behind us —
APC is here to help you
get ready for FTTN.

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BROADBAND ROUTER REVOLUTION

We test the latest
modemless broadband
routers that could
revolutionise your
home network.

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GETTING HOOKED UP TO THE NBN: WHAT YOU NEED TO KNOW

Confused about what's
involved with getting
the NBN hooked up?
We outline all the
essential info you
need to know.

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NETWORKING ACCESSORIES

Boost the performance
of your existing network
with a wireless range
extender, powerline
Ethernet device
or faster Wi-Fi adapter
for your PC.

MU-MIMO means we can finally start to see an end to this kind of thing.



Create the ultimate home network

Confused about what you need to set up the best home or SOHO network? Nathan Taylor reveals all in our detailed guide.

So the time has come to rebuild your home network. Perhaps you just got upgraded to the NBN. Perhaps you're just sick of crummy Wi-Fi performance and you'd like to be able to stream Netflix without buffering to anywhere in your house. What should you be looking for in a 2017 home network?

THE HOT NEW THINGS FOR 2017

There are changes afoot in the world of consumer networking, and it's absolutely worth knowing a little about them if you're planning on upgrading your home network any time soon. There are three primary things you should be looking at this year:

MU-MIMO, FOR REALSIES.

Back in 2015, we started seeing enormous routers and access points with forests of antennae producing tri-band networks for serving multiple devices. Thankfully, we're starting to see the end of that trend as we move to MU-MIMO and mesh networks.

This all probably requires some explanation. It comes down to how clients in the real world access the

network. MIMO was a technology introduced back in the 802.11n era, allowing multiple antennae to transmit spatially diverse signals, multiplying the effective speed. If you had two antenna arrays (called 2X2 MIMO), each array could send its own stream, doubling the speed of the network. In 802.11n, you could have up to four streams (4X4) and, in 802.11ac, you can technically have eight streams, though we've never seen more than four in consumer devices.

But the thing about MIMO is that for it to work, the devices at both ends of the link need to support it. A 4X4 device talking to a 2X2 device only talks at 2X2. And almost no consumer devices have more than 2X2. Laptops, mobiles and most USB adapters tend to be limited to two streams (at best). So that fancy 1,766Mbps four-antenna router you bought is mostly wasted because the client device can't go faster than 867Mbps.

Then we had the tri-band network devices (not to be confused with 802.11ad devices). Because most client devices supported only slower speeds, they split the network up into multiple





The first MU-MIMO routers, like the Linksys EA8500, started shipping in 2015.

A lot of mesh network solutions, like Linksys' Velop, haven't quite made it out here yet.

TP-Link's Talon AD7200, one of the first and only routers to support 802.11ad.

independent Wi-Fi networks, each with their own SSID and band. So instead of one six-stream network, you had two three-stream networks. That way, several devices could access the network at once without getting in each others' way. It was ugly, but it kind of worked.

But MU-MIMO, introduced in so-called 'Wave 2' routers in 2015 and 2016 solved that. Now multiple devices can talk to the network without competing for bandwidth, using the same spatial division multiple access technique used by MIMO, but this time from the client side. Your two 2X2 devices can talk to a 4X4 MU-MIMO router at the same time at full speed, for example.

For MU-MIMO to work, however, you need clients that support it. And while it's far from universal, the number of devices that support it has grown considerably. Many phones support it, including the Google Pixel, Samsung Galaxy S7, Microsoft Lumia 950, some ASUS ZenPad and ZenFone models, new HTC One models and others. It's not just the super-expensive phones either; Microsoft's Lumia 640 and Sony Xperia M2 support it as well.

On laptops, the story has got better as well. The Acer V13 Ultrabook and Aspire V Nitro, Dell Latitude, XPS and

"For MIMO to work, the devices at both ends of the link need to support it. A 4X4 device talking to a 2X2 device only talks at 2X2."

Alienware models (look for devices with Killer 1535 wireless), as well as some MSI gaming laptops support it, and the list is growing.

All that means that you'll get good speeds, from multiple devices at once, without having to massively over-provision your home network or deal with multiple Wi-Fi networks. It makes things much simpler.

802.11AD

OK, to be honest, we're not really sure how 'hot' 802.11ad is. It may be just another one of those periodic ideas that falls by the wayside. But we are seeing a few more routers coming out that support it.

The idea behind 802.11ad routers is that they use a third band, the extremely high frequency 60GHz radio band (regular Wi-Fi uses the 2.4GHz and 5GHz bands). At this high frequency, the radio signals can carry a lot of data

— up to 7Mbps — but they can't go through walls.

That makes it essentially a same-room/line-of-sight technology for fast connection to wireless peripherals. It's seen as a useful tool for connecting to external SSDs and displays, and especially useful for wireless virtual reality headsets.

Given that the devices and the access point or router need to be in the same room, we're not sure how much traction it will get with users, and almost no client devices support it right now. So it's not a high-priority inclusion in home networks... for the moment.

MESH NETWORKS

Perhaps the biggest story in networking this year is the growth in wireless mesh networks for the home. Mesh networks aren't new — they're frequently used in hotels, airports, museums and office buildings — but in

the home, we've been stuck with single-router solutions for a long time now.

However, last year, we saw the first mesh networks for home users appear. Ubiquiti's AmpliFi, eero, Netgear's Orbi, Linksys' Velop and others were released in the US and they worked fantastically, finally solving the range problems so many people in larger and multi-storey homes have endured. Unfortunately, we've yet to see many of those solutions come to our shores. AmpliFi and Orbi are widely available for retail, but you might have to go to eBay importers for some of the other products.

Mesh networks use multiple access points to provide better coverage and allow smaller cells, so that there are fewer wireless signals overlapping with each other. With a mesh network, you don't just place a single router — you strategically position two or more access points around the home to provide proper coverage everywhere.

These access points talk to each other using a wired or wireless backhaul network, and your device will automatically connect to the nearest access point to maximise speed. As you move around the house, there should be an invisible (to you) hand-off, so that you'll always be connected to the fastest access point.

From a user perspective, they're very easy to set up. You buy a network mesh kit with as many access points as you need to cover your house. You position the primary router/access point next to wherever your internet comes in. Then you position additional ones around the house where needed. If you're using wireless backhaul (rather than connecting them via an Ethernet cable), each access point has to be within Wi-Fi range of another point — though they don't necessarily have to be in range of the primary, since the secondary points can relay. Once you've positioned them, you can usually use a mobile or desktop app to configure them all at once.

Although there are multiple access points, you'll only see a single SSID when you connect to a mesh network from a wireless device. Connecting to that one will automatically connect you to the closest access point — and as you move around, you'll be handed off to the best access point.

We'll talk a lot more about mesh networks in the section on range expansion (opposite), since they're a big deal for home users.

The right hardware for you

So with all that in mind, what's the best hardware you should be looking for right now?

Obviously, the place to start is with your WAN requirements. If you're on ADSL or fibre to the node (FTTN), you'll need a modem router, and even if you only have ADSL right now, you should absolutely look for a modem router that supports VDSL, the standard used by FTTN. If you're on ADSL now, chances are that your NBN solution is going to be FTTN, and getting a VDSL modem router means that you can just leave it in place when the NBN finally comes your way. You won't even have to change any ports around.

If you're on cable right now, it's probably not a good time to upgrade. The situation with cable on the NBN could best be described as 'fluid'. Which is to say, nobody really knows what's going to happen. There has been a trial migration to the NBN cable in some areas, but other areas with cable are being moved to FTTN, meaning that a whole new router will be needed (check NBN Co's rollout map at nbnco.com.au to get an indication of what you're getting). There are also plans to move NBN cable to a new cable standard (DOCSIS 3.1) later this year, which will require new modem routers.

If you're on FTTH, satellite or fixed wireless, you only need a broadband router with an Ethernet WAN port. The NBN equipment installed in your house has the modem built in.

For local connectivity, you should be looking for gigabit Ethernet support, as well as 802.11ac with MU-MIMO and at least 3X3 antennae. We wouldn't look too much at wireless AC ratings — in a lot of cases, they've been heavily manipulated to blow up the numbers. For example, a lot of routers use unofficial modulation techniques to boost their AC numbers — modulation techniques that few clients actually support and so are kind of meaningless.

Instead look at the number of antennae and the MIMO support in the specs for both the 2.4GHz and 5GHz. As an aside, we don't think tri-band routers are desirable for many households, especially since the access points are in the same spot. To put it simply, you're better off with two access points/routers that you can place in different positions than you are with a single router that produces multiple Wi-Fi networks.

Ideally, if you can afford it, we would start seriously looking at a mesh network. None of them right now include modem routers, so you will need a separate modem router if you're on DSL or cable. But you can buy a cheap VDSL/cable modem router and put it into bridged mode, turning off all its routing and wireless functions and having it just serve as a modem. Then you connect the WAN port of your broadband/mesh router to a LAN port on the DSL/cable modem router and use the broadband mesh router as your primary routing device.

If you don't have a mesh network, you should try to position your router in the middle of the home as much as possible to maximise wireless coverage. With a mesh kit, you can place the primary node right next to your modem router and then spread the other nodes around the house to get as much coverage as possible. If you can, connect the mesh nodes to each other using an Ethernet cable, which provides the best backhaul solution. If that's not an option, then don't worry — it should still work pretty well as long as each node is in Wi-Fi range of another.

A lot of mesh networks come in kits with a primary router plus extension nodes.



EXPANDING YOUR COVERAGE

One of the biggest issues many home users face is the issue of Wi-Fi coverage. With pretty much every device having Wi-Fi now, you want a strong signal available wherever you go. Oftentimes, a single router solution doesn't cut it, and you find that the Wi-Fi signal is too weak. In some cases, you might be able to move the router to get better coverage, but that might not be an option for you, and in some cases (like multi-storey homes), it might not make a difference.

If that's the case for you, there are three relatively simple solutions we can suggest. There are other options – high gain and directional antennae, for example – but these are the ones most likely to appeal to most home users. In order, from most desirable to least:

DEPLOY A MESH NETWORK

We've talked a lot about mesh networks here, and that's simply because they solve a lot of problems. Relative to the other solutions below, they offer:

- **Simple setup:** Usually a single app will set up all your mesh nodes.
- **Single SSID:** It all appears as one single Wi-Fi network.
- **Seamless roaming:** You can move around, from node to node, without losing connectivity.
- **Good performance:** Range extenders hit bandwidth hard, effectively halving it. A mesh network uses a backhaul network, either wired or wireless, potentially bypassing this issue. (We should note this varies

from device to device. Netgear's Orbi, for example, creates a dedicated Wi-Fi network in a different channel, so there's no impact on performance. On the other hand, Ubiquiti uses the same channel for connecting to nodes as it does for client communications.)

Setting up a mesh network is usually just about figuring out the right positioning for the satellite nodes. Once they're all plugged in, you can use the mobile app to configure them all at once. As we mentioned previously, ideally the nodes are connected back to the primary router via an Ethernet cable, which will maximise speed and minimise latency, but wireless connectivity is OK as well.

The one downside of a mesh network is that, right now, they're all vendor-specific. You can't mix and match pieces; if you buy a Netgear Orbi, you can only extend it with Netgear Orbi components.

A SECOND ROUTER/ACCESS POINT, LINKED BACK TO THE ORIGINAL WITH AN ETHERNET CABLE

One of the easiest ways to extend a network is simply to buy a second router or access point. Just follow these steps:

- Plant it in a position in your house where it will provide the wireless coverage you need.
- Link it back to your primary router with an Ethernet cable, from LAN port to LAN port.
- Set its wireless SSID and password to the same as your primary router.

Setting its wireless SSID and password to be the same as your primary router means that your wireless devices will automatically connect to it if they're getting a stronger signal from it. Which is to say, that your wireless devices will figure out automatically whether to connect to your secondary or primary wireless router based on signal strength. You can also plug wired devices into the secondary router/access point and they will work just fine.

There is the issue that clients can be 'sticky', and there's no hand-off like you get with mesh networks. If you move from one router's zone to the other's, your mobile won't automatically switch over unless it loses the original signal completely. Instead, you have to disconnect and reconnect, interrupting your internet connection. There is, thankfully, an app on Android that will do that for you: Wifi Switcher (available on Google Play), which will swap you over to a better network if the one you're connected to falls below a signal power threshold.

A RANGE EXTENDER

This is probably the least desirable option. A range extender is a device that creates an independent wireless network and bridges it back to the primary wireless network. So you set up a range extender as, essentially, an independent access point and your device connects to it. Then it relays data received on its own Wi-Fi network back onto the primary network. As long as the primary Wi-Fi network is in range of the extender, it should work.

There are problems with this. Because it's both receiving and repeating wireless signals in the same band, effective speed is halved. We've also had major issues with latency on a lot of models.

On the other hand, extenders are generally easier and cheaper to set up than the alternatives, and don't require that you run cables. Like a mesh, it can communicate back to the primary network over Wi-Fi. They're also capable of working with any network – you can have a TP-Link extender and Linksys router, for example.

If you do want to go with a range extender, we'd recommend a free standing one to one of the small power-point extenders. They simply have better Wi-Fi. You should also look for cross-band support, which can solve some of the bandwidth problems. With cross-band, it can receive data on the 2.4GHz band and relay it on the 5GHz band and vice versa, which solves some of the bandwidth halving problem. It won't fix latency or the problem of having distinct Wi-Fi networks, but if all you care about is getting coverage at all, an extender will get the job done. ■



Switch Range

Signal Level at which to switch access points.

Switch Range

Decibels at which to switch access points. (Pro Only)

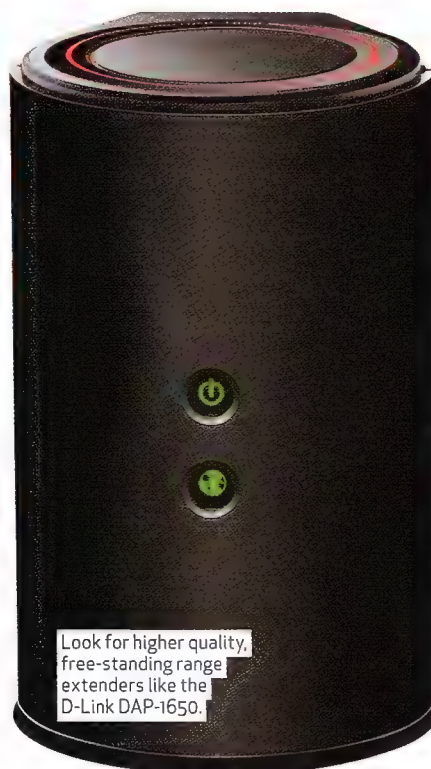
Ask Before Switching

The app will switch between routers only once you tell it to.

Show Full SSID

Checking this box will show the full SSID for each Access Point. Checking this may cause some of the SSIDs to go off screen

Wifi Switcher is an excellent app if you have multiple access points set up in your home.



Superspeed ADSL routers

Nathan Taylor is here to help you get connected to FTTN.

It wasn't so long ago that ADSL was considered a dying technology in Australia. As we were headed to our bright fibre future, ADSL was going to be phased out along with the old copper network.

The Coalition's multi-technology mix NBN changed all that. At least a third of Australians are going to be on fibre to the node, which continues to use ADSL technology for the last few hundred metres to the home. That means you'll likely still need an ADSL modem router – but not the same one you used for ADSL. You now need a modem router that supports VDSL, the standard used by FTTN.

If you're making that move to FTTN or are prepping for it, we've got reviews of seven top ADSL routers below. All support VDSL as well, so they've got you covered for now and for when the FTTN hits your area.

HOW WE TESTED

For all the routers here, we performed a straight file copy test from a server attached to the router via Gigabit Ethernet. At both 5m (with line of sight) and 15m (with two intervening plaster walls), we copied a 1GB file from the server to a laptop attached to our trusty old Linksys WUMC710 wireless bridge. The WUMC710 is one of the few client devices capable of 1,300Mbps wireless AC with a 3x3 antenna.

As always with wireless tests, there is certainly a case of your-mileage-may-vary. The numbers presented are only useful for comparison, and are not necessarily an indication of what you might get in your specific home environment.

ADSL ROUTER WIRELESS PERFORMANCE

RANGE	COPY SPEED (MB/S)*	
	5M	15M
ASUS DSL-AC68U DUAL-BAND WIRELESS-AC1900 ADSL/VDSL MODEM ROUTER	63.23	23.6
AVM FRITZBOX 7490	61.3	19.9
D-LINK DSL-4320L TAIWAN AC3200 ULTRA-WIFI MODEM ROUTER	64.1	25.3
DRAYTEK VIGOR2860VAC	56.2	17.6
LINKSYS X6200 AC750 WI-FI VDSL MODEM ROUTER	16.5	6.8
NETGEAR NIGHTHAWK D8500 TRI-BAND WIFI VDSL/ADSL MODEM ROUTER	61.3	28.5
TP-LINK ARCHER VR2600	66	27.3

TESTED USING A 1GB FILE COPY FROM PCS ATTACHED TO ROUTER AND A CISCO LINKSYS WUMC710 ADAPTER/BRIDGE.

Wireless: 1,300Mbps AC, 600Mbps N (using 3x3 MIMO); **WAN ports:** one ADSL/VDSL port, one gigabit WAN port; **LAN ports:** four gigabit ports; **USB:** one USB 3.0 port



\$310 | WWW.ASUS.COM.AU

ASUS DSL-AC68U Dual-band Wireless-AC1900 ADSL/VDSL Modem Router

An older product, but it still checks out.

Like many router manufacturers, ASUS tends to reserve its best tech for its broadband routers, leaving poor ADSL users languishing on older products. So even though it's been kicking around for a few years now, the DSL-AC68U remains ASUS's most advanced ADSL product.

That said, it was a damn fine product when it was released and remains so now. A big part of that comes down to the ASUS WRT firmware, which is the best in the business.

Based on the open-source OpenWRT firmware, ASUS has modified it to be both easy to use and very capable. It supports VPNs out of the box, both client and server. It has per-user traffic monitoring, capable time-based parental controls and support for using a USB LTE modem as a primary or secondary WAN (with failover and load balancing). It also plugs into ASUS's AiCloud service, allowing

you to access to the content of a drive attached to its USB 3.0 port remotely.

For all its capabilities, it manages to be straightforward to set up and use, with an attractive mobile app to get it configured quickly. The mobile app even allows access to some of the more advanced capabilities, although if you want to really get down in the weeds with VPNs and the like, you'll need to log onto the main admin console.

The hardware is capable enough for most home users, with well-performing 3x3 MIMO and good signal reception in our wireless tests. It doesn't have MU-MIMO or tri-band, but it should be plenty powerful for most homes.

Verdict

Older but still-capable wireless tech combines with the industry's best firmware. Recommended.



Wireless: 1,300Mbps AC, 450Mbps N (using 3x3 MIMO); **WAN ports:** one ADSL/VDSL port; **LAN ports:** four gigabit ports (one can be reassigned to WAN); **USB:** two USB 3.0 ports



\$250 | EN.AVM.DE

AVM Fritz!Box 7490

Amazing telephony.

Although AVM has recently released the MU-MIMO-supporting FRITZ!Box 7580 in its native Germany, that model has yet to make it to our shores. For the moment, we're stuck with the older Fritz!Box 7490. 'Stuck' is perhaps not the right word – like ASUS's DSL-AC68U, it may not be up to the latest Wave 2 wireless spec, but it's still excellent. When it comes to telephony, there's none better.

It's one of a handful of extant routers that still supports integrated voice over IP. There's a PSTN failover port in case of internet outages, a port for regular analogue phone handsets and an integrated DECT base station, so you can sync cordless phone handsets directly. There are multiple voicemail boxes (stored locally or on a hard drive), cloud-saved contact lists, alarms and automated wake-up calls and more. There's even a mobile app that lets you make voice

calls on your mobile using the VoIP service.

AVM's firmware is great as well. It supports VPNs and a lot of advanced features. You can reassign one of the LAN ports as a WAN port, and there are capable access control and monitoring rules in place. It's certainly not as accessible as the similarly capable ASUS firmware, however, and the suite of mobile apps for the platform aren't that easy to grasp either. Initial setup is easy enough, but tweaking some of the more advanced settings requires some networking know-how.

The hardware supports USB 3.0 on both its ports and 3x3 MIMO for wireless in both bands. The Fritz!Box 7490 is quite the bargain.

Verdict

Awesome for VoIP, and still very capable overall for an older solution.



Wireless: 1,300 + 1,300Mbps AC, 600Mbps N (using 3x3 MIMO); **WAN ports:** one ADSL/VDSL port; **LAN ports:** four gigabit ports (one can be reassigned to WAN); **USB:** one USB 2.0, one USB 3.0



\$500 | WWW.DLINK.COM.AU

D-Link DSL-4320L Taipan AC3200 Ultra-Wi-Fi Modem Router

A unique approach to mesh networking.

When we first looked at the DSL-4320L about a year ago, it was one of the very first tri-band modem routers on the market. Where tri-band solutions are readily available on broadband routers, few modem routers have it. A year later, it remains one of the only products to have the technology (plus the Netgear, below).

Something else has been added, too. D-Link calls it 'Whole Home Wi-Fi', a kind of mesh-lite networking technology. D-Link routers and range extenders marked with this label can form a mesh-like network with proper roaming and a single shared SSID. That means you can move around your house, between access points and routers, without losing the connection or having to reconnect to a second network. It's not as elegantly implemented as Ubiquiti's AmpliFi, however.

The tri-band nature of the Taipan actually makes it a

good option for this.

Tri-band, in this instance, means one 2.4GHz network and two 5GHz networks, and devices are split between them to balance load. We're not generally huge fans of tri-band, but it works here: since the D-Link Whole Home Wi-Fi system uses in-band repeaters, which reduce bandwidth, having a second AC network actually works quite well, since that can serve as a functional backhaul network.

It doesn't have MU-MIMO, but the updated firmware from D-Link is very good, and boasts some advanced capabilities like VPN support, OpenDNS-based parental controls and remote access to attached USB storage. The mobile apps are accessible as well.

Verdict

A good choice if you're looking to couple it with D-Link range extenders. But expensive.



super » superspeed ADSL routers

Wireless: 1,300Mbps AC, 300Mbps N (using 3x3 MIMO); **WAN ports:** one ADSL/VDSL port, one gigabit WAN port; **LAN ports:** ix gigabit ports; **USB:** two USB 2.0 ports

Wireless: 433Mbps AC (1x1), 300Mbps N (2x2); **WAN ports:** one ADSL/VDSL port, one gigabit WAN port; **LAN ports:** four gigabit ports; **USB:** one USB 2.0 port



\$590 | WWW.DRAYTEK.COM.AU



\$145 | WWW.LINKSYS.COM.AU

DrayTek Vigor2860Vac

A small business VoIP router with enterprise-level tools.

Like most DrayTek products, the Vigor2860Vac doesn't pull any punches. It's an extremely capable VoIP and security router, but DrayTek rather expects you to know your networking stuff if you want to get it up and running. There are no easy setup wizards, no dumbed-down mobile apps. It's all business, and it expects you to know yours.

If you're comfortable with terms like 'SIP registrar', 'VLAN' and 'SSL VPN', however, the DrayTek gives you an awful lot of tools to work with. Very detailed traffic monitoring and management, VPN server and client (with up to 32 tunnels), content management support for business network filtering, centralised management if you have multiple DrayTek routers set up, VLAN segmentation, using a USB LTE modem as a failover or load-balanced and much more is built in. There are a lot of enterprise-class tools

here, if you know how to use them.

When it comes to VoIP, its functionality is a little raw – especially when compared to something like the Fritz!Box. Essentially, it provides basic connectivity, with two handset ports and a single PSTN failover port and not much else. Don't expect voice mail or wake-up calls.

The hardware is otherwise fairly mid range. It's nice that it has six LAN ports, as well as a hard WAN port, in addition to the modem port, and all of these are up front for easy access. Wireless is so-so, and it doesn't support MU-MIMO (though that's true of most modem routers).

Verdict

Very advanced routing and security features, but very expensive and with weak VoIP capabilities.



Linksys X6200 AC750 Wi-Fi VDSL Modem Router

A low-cost VDSL option.

Not every VDSL router has to be a \$250 powerhouse. For people with modest wireless needs looking for a low-cost solution, Linksys has released the X6200, a compact, simple device designed for basic connectivity.

With only single stream (433Mbps) 802.11ac support and dual-stream 802.11n support (300Mbps), it's best suited for people who don't do much video streaming over wireless. 433Mbps is enough for a single device at short range to be streaming HD Netflix for example, but we wouldn't want to test it with more than one.

It uses the same firmware as nearly all Linksys routers – firmware that's easy to use and often has surprising depths, but lacks advanced features like VPN support, VLANs and traffic management.

It has schedule-based parental controls and can work with OpenDNS for blacklist blocking. It can be

fully managed from Linksys' revamped mobile apps, which make the initial setup of the modem router a breeze.

It has the conventional four gigabit LAN ports, and it has a hard Ethernet WAN port in addition to its ADSL/VDSL port, which can come in handy if you find yourself moving to a fixed wireless or FTTH service. It has a single USB 2.0 port for shared storage devices.

Its greatest virtue, however, is its price. If you have a more capable access point/broadband router or you're setting up a mesh network and just need VDSL connectivity, this is pretty much the ideal solution. You can switch off the wireless, set it to bridged mode and let it be a 'dumb' modem.

Verdict

If you're looking just for a cheap modem, this gets it done.



Wireless: 2,166 + 2,166Mbps AC, 1,000Mbps N (using 4X4 MIMO); **WAN ports:** one ADSL/VDSL port, one gigabit WAN port; **LAN ports:** six gigabit ports (two with link aggregation); **USB:** one USB 2.0, one USB 3.0



\$700 | WWW.NETGEAR.COM.AU

Netgear Nighthawk D8500 Tri-Band WiFi VDSL/ADSL Modem Router

Specs out the wazoo.

If you're looking for a modem router with the best possible specs, here it is. While many vendors' modem routers lag behind their broadband routers, the new D8500 has specs to match any broadband router – tri-band AC5300 (2,166Mbps + 2,166Mbps + 1,000Mbps), six gigabit LAN ports with link aggregation, MU-MIMO support and USB 3.0 support for storage attachment. It also manages to be somewhat more compact and elegant than most AC5300 routers, since four of its antennae are internal.

There are a lot of things to love here. The LAN port link aggregation is a great idea – a lot of current NASes have load-balanced dual Ethernet ports, and this allows you to take full advantage of it, with several devices able to access the NAS at full gigabit speed. We also love the proper blacklist-based parental controls. It uses OpenDNS, which Netgear makes simple by integrating

it right into the admin interface and mobile app.

And then there's the wireless. It's probably overkill for most homes. It supports 4x4 MIMO across the board, in all three of the Wi-Fi networks it creates. Like most tri-band routers, it automatically assigns devices to one of its wireless networks based on load and device type.

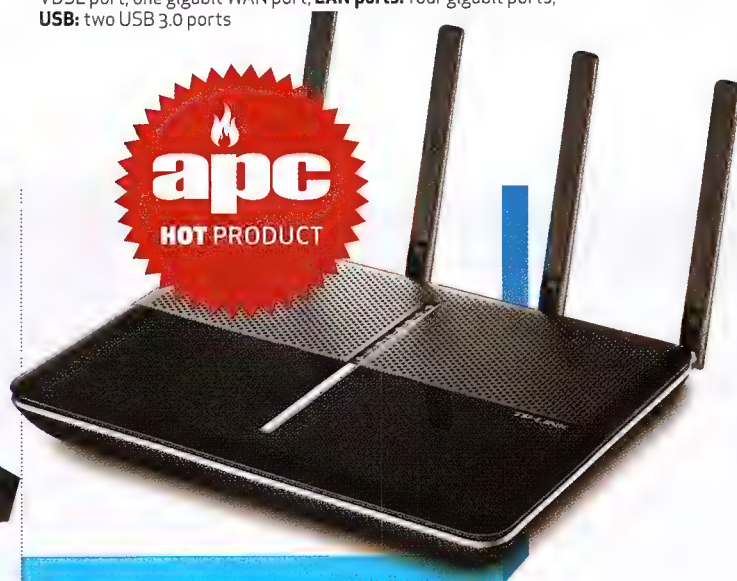
Given the specs, you'd probably expect to pay through the nose for the Nighthawk, and you'd be right. \$700 for a router that doesn't have VPN or advanced networking features is a lot to ask, but if you want the best hardware specs for a VDSL modem router, this is the product that has it.

Verdict

Amazing specifications for a modem router, but probably overkill for a lot of home users.



Wireless: 1,766Mbps AC, 800Mbps N (using 4x4 MIMO); **WAN ports:** one ADSL/VDSL port, one gigabit WAN port; **LAN ports:** four gigabit ports; **USB:** two USB 3.0 ports



\$370 | WWW.TP-LINK.COM.AU

TP-Link Archer VR2600

High-end wireless without a nutso price.

TP-Link has struck an excellent balance with its new VR2600 modem router. It has premium wireless without going overboard like the Netgear (left), a nice suite of ports, capabilities and apps and an ever-improving setup process that makes getting it up and running easier than ever.

It's one of the few VDSL modem routers with support for MU-MIMO Wi-Fi baked in, and a 4x4 antenna array gives it plenty of bandwidth to work with. Its peak physical rate is 1,766Mbps, which is plenty to serve high-definition media streams to four or more devices simultaneously.

It also has an Ethernet WAN port built in, and it makes good use of it twin USB 3.0 ports, with smooth DLNA streaming and support for USB LTE modems – with load balancing or failover to the LTE network. It has time based parental controls, and can, of course, be set up

with OpenDNS for blacklist-based controls.

One of the biggest areas of improvement for TP-Link has been its mobile apps. In the past, we've occasionally been critical of TP-Link's setup and management, and while it's still not as streamlined and accessible as, say, Linksys or ASUS, getting the router up and running is a process that now anybody should be able to handle. In particular, the TP-Link Tether app give you access to all of the routers most important features, including parental controls, 3G/4G and security.

Overall, we think TP-Link is onto a winner here, with a great set of features without going nuts.

Verdict

A well-balanced modem-router, with premium wireless and reasonable price tag.



Broadband router revolution

Nathan Taylor tests the latest modemless broadband routers — including mesh networking models — that could revolutionise your home network.

So you don't need a modem, or maybe you're prepared to just buy a cheap modem router because you want a proper dedicated broadband router running your home network. It's certainly true that you have more options when it comes to broadband routers than you do with modem routers. The newest tech tends to be implemented in broadband routers long before it comes to modem routers.

Below, we've looked at some of the top broadband routers currently available, including several new mesh networks designed for people tired of crummy Wi-Fi coverage in their home.

HOW WE TESTED

We tested broadband routers the same way we tested ADSL modem routers. We performed a straight file copy test from a server attached to the router via Gigabit Ethernet. At both 5m (line of sight) and 15m (with two intervening plaster walls), we copied a 1GB file from the server to a laptop attached to a Linksys WUMC710 wireless bridge. The WUMC710 is capable of 1,300Mbps wireless AC.

We should note that, in the case of mesh solutions, we also performed additional bridged testing, as noted in the reviews.

As always with wireless tests, there is certainly a case of your-mileage-may-vary. The numbers presented are only useful for comparison, and are not necessarily an indication of what you might get in your specific home environment.

BROADBAND ROUTER WIRELESS PERFORMANCE

RANGE	COPY SPEED (MB/S)*	
	5M	15M
ASUS RT-AC5300 802.11AC TRI-BAND GIGABIT ROUTER	65.8	24.1
D-LINK DIR-895L AC5300 MU-MIMO ULTRA WI-FI ROUTER	64.2	26.8
DRAYTEK VIGOR2925AC	54.1	13.5
LINKSYS EA9500 MAX-STREAM AC5400 MU-MIMO GIGABIT ROUTER	66.7	23.1
NETGEAR ORBI*	39.3	14.2
TP-LINK ARCHER C3150	64.4	28.6
UBIQUITI AMPLIFI MESH WI-FI SYSTEM*	59.4	22.2

TESTED USING A 1GB FILE COPY FROM PCS ATTACHED TO ROUTER AND A CISCO LINKSYS WUMC710 ADAPTER/BRIDGE.

*DIRECT TO ROUTER. SEE THE REVIEW FOR SPEEDS WHEN USING A SATELLITE/MESHPPOINT.

Wireless: 2,166 + 2,166Mbps AC, 1,000Mbps N (using 4x4 MIMO); WAN ports: one Gigabit Ethernet; LAN ports: four gigabit ports; USB: one USB 2.0, one USB 3.0



\$490 | WWW.ASUS.COM/AU

ASUS RT-AC5300 802.11ac Tri-band Gigabit Router

All the best stuff.

A monstrous, alien-looking thing, the ASUS RT-AC5300 is one of those 'best of everything' tri-band routers, boasting 4x4 antennae for all networks, MU-MIMO and a host of top of the line features not commonly found in consumer routers.

It's capable of 2,166/2,166/1,000Mbps across the three independent Wi-Fi networks it creates. Those numbers are possible due to the use of NitroQAM, an unofficial modulation technique that needs to be supported by client devices. Devices are assigned dynamically to a Wi-Fi network based on load, and with MU-MIMO, you can have lots of devices running at full speed simultaneously.

If that wasn't impressive enough, ASUS's shipped firmware is the best in the business. It supports a host of features that you'd normally have to look to third parties for, including VPN support, per-user traffic management, LTE modem support and remote

access to storage devices attached to its USB ports. ASUS's management interface and mobile apps are excellent, too.

This router also features support for the WFast gaming network, which is a VPN-like service designed to optimise ping times for select gaming services. The game support is limited right now — *DOTA*, *League of Legends*, *Counter-Strike* and *WoW* are supported — and more games are promised. The free service is also limited to one device at a time. We tested out the router with *World of Warcraft* and found little noticeable improvement in ping times to the US servers.

With all the features available to it, this is a powerhouse and a top pick.

Verdict

It's on the expensive side, but the features and performance can't be beat.



Wireless: 2,166 + 2,166Mbps AC, 1,000Mbps N (using 4x4 MIMO);
WAN ports: one Gigabit Ethernet; LAN ports: four Gigabit ports;
USB: one USB 2.0, one USB 3.0



\$650 | WWW.DLINK.COM.AU

D-Link DIR-895L AC5300 MU-MIMO Ultra Wi-Fi Router

All the bells and whistles.

Like the ASUS RT-AC5300 (left), the D-Link DIR-895L is a top-of-the-line model, a huge space-crab looking thing with a forest of antennae and the very best wireless that you can get right now. It's a tri-band model, with 4x4 MU-MIMO support across the board.

Recent updates to its firmware have also improved its underlying usability and feature set. New D-Link routers such as the DIR-895L now have a capable and visual interface not unlike that of Linksys. There are some nice elements there, like an accessible quality of service engine and easily grasped schedule-based parental controls, and the mobile apps (much improved from previous iterations) provide both robust management and remote access to media stored on USB drives attached to the router.

However, the DIR-895L does not currently support D-Link's Whole Home Wi-Fi network technology. Indeed,

none of D-Link's broadband routers do, though the DSL-4320L we reviewed in the ADSL modem router section can do duty as a broadband router and supports it. It's a real shame the DIR-895 doesn't support it – it's a good system, and it might go a long way to justifying the very notable price premium the D-Link has over the similarly-specced ASUS RT-AC5300 and Linksys EA9500.

As it stands, the D-Link has about the same hardware as the ASUS, but inferior firmware and a price tag that's \$160 higher. It's a good product, but you can get better for less.

Verdict

The hardware is powerful, but it's too expensive.



Wireless: 1,300Mbps AC (using 3x3 MIMO), 300Mbps N (2x2);
WAN ports: two Gigabit Ethernet ports; LAN ports: five gigabit ports;
USB: two USB 2.0



\$480 | WWW.DRAYTEK.COM.AU

DrayTek Vigor2925ac

Powerful business tools.

In contrast to the user-friendly consumer devices provided by the other vendors, DrayTek is focused on the small business market. Like most DrayTek products, the Vigor2925ac is made for people who don't expect to use an idiot-proof app to set up their router. It's hardcore, but if you're also hardcore, it has security and routing features that no other router in this price range can match.

Those features include precise and detailed VLAN segmentation, support for VPNs of every flavour (with up to 50 tunnels), LTE modem support, advanced network traffic monitoring and analysis, complex QoS tools, SNMP support, Cyren web content filtering and quite a bit more. We don't love DrayTek's VPN setup, especially the way SSL is tacked on rather than integrated, but the tools are all there for enterprise-class router management and control.

When it comes to the hardware, it is nice that it has an extra LAN port over the usual four, and having two WAN ports means that business users can load balance across multiple WANs. But the 3x3 wireless antennae are weak and it doesn't have support for MU-MIMO. It did not do well in our testing. The wireless feels a little tacked on.

It's also expensive. Given that it's a true security router, that's not entirely unexpected, but you could use an open firmware like OpenWRT to build an equally capable security router for less. It does have support for services that you won't find in an open-source firmware, and that may be enough to tip the scales in its favour.

Verdict

A capable business router with a lot of advanced networking tools, but a little too expensive.



super » broadband routers

Wireless: 2,166 + 2,166Mbps AC, 1,000Mbps N (using 4x4 MIMO); WAN ports: one Gigabit Ethernet; LAN ports: eight gigabit ports; USB: one USB 2.0, one USB 3.0



\$490 | WWW.LINKSYS.COM/AU

Linksys EA9500 Max-Stream AC5400 MU-MIMO Gigabit Router

Possessing mesh-like features.

Another kitchen sink router in the vein of the ASUS RT-AC5300, the EA9500 has all the latest wireless tech while also being rather more compact than the competition.

It also happens to be one of the routers in Linksys' range that supports Seamless Roaming, a mesh-lite technology similar to D-Link's Whole Home Wi-Fi. It allows you to set up a Wi-Fi network of MAX-STREAM routers and range extenders using a shared SSID. You can roam from access point to access point without losing the connection or needing to switch Wi-Fi networks – though it is still in-band, so you will have a hit on throughput just as you would with a normal range extender. These circumstances allows tri-band routers to really come into their own.

The Linksys supports 4x4 MU-MIMO on all three of its bands, and with 1024QAM modulation support can

technically hit 2,166/2,166/1,000Mbps, which is about the fastest you can get in a consumer router. It has a super-generous total of eight gigabit LAN ports, giving you plenty of wired connectivity as well.

It also has one of the best mobile setup and management applications, with very fast, very simple configuration and access to all of the router's important features from a consumer-friendly interface.

The Linksys firmware does not have close to the feature set of, say, ASUS, but it covers most of the things that an average consumer might need, from device and user management, to parental controls, to DLNA, to automated quality of service.

Verdict

The support for Seamless Roaming really sets the Linksys apart from the other AC5300 routers.



Wireless: 866 (using 2x2 MIMO) + 1,733Mbps (4x4 MIMO) AC, 400Mbps N (using 2x2 MIMO); WAN ports: one Gigabit Ethernet; LAN ports: three gigabit ports on router, four on satellite; USB: one USB 2.0 on router, one on satellite



\$670 | WWW.NETGEAR.COM/AU

Netgear Orbi RBK50 (kit of two)

The perfect mesh kit.

Netgear's entry into the world of dedicated home mesh networks gets just about everything right. Comprising of a router and one or more satellites, the Orbi devices look like strange vases with LED lights at the top. Even the satellites have Ethernet ports, either for connecting devices or linking back to the router.

Set the router up as your primary routing device, then place the satellites around your home as needed to expand the coverage. As long as they can talk to the primary router, either through Ethernet or Wi-Fi, you have a mesh network.

What sets the Orbi apart is its dedicated wireless back channel that's only used for linking the satellites and router. That means that your bandwidth won't be halved if you're attached to a satellite as opposed to the router. You'll get full speed everywhere.

The backchannel network is 1,733Mbps (4x4 MU-

MIMO) and the two user channels are 866Mbps and 400Mbps (2x2 MU-MIMO). That limits individual device speed, but that's not a problem since most devices only support 2x2 MIMO max (we tested with a rare 3x3 device so it looks worse in the results table than it is).

The tri-band design made a huge difference when testing attached to the satellite. At 15m from the router, with the satellite placed between the test station and router, we were still hitting 37MB/s, which is phenomenal.

This is the best mesh networking system we've seen. With USB ports and full support for routing features, this is a near perfect solution.

Verdict

Guys, I think we've found our new favourite wireless kit. Easy to set up and phenomenal performance.



Wireless: 2,166Mbps AC, 1,000Mbps N (using 4x4 MIMO);
WAN ports: one Gigabit Ethernet port; LAN ports: four gigabit ports;
USB: one USB 2.0, one USB 3.0



\$300 | WWW.TP-LINK.COM.AU

TP-Link Archer C3150

A balanced router.

Although TP-Link also sells an AC5400 router in the style of the high-end ASUS and Linksys routers reviewed here, we're actually big fans of its more affordable mid-range products, which strike a nice balance between capability and price. The Archer C3150 is one such product.

It's a 4x4 MU-MIMO dual-band wireless router, meaning that it has enough bandwidth and capacity to support a mid-to-large home or office with numerous devices capable of streaming HD media at once. It's elegant and nice enough looking for public placement, and it has a user-friendly mobile app to get things up and running.

We've historically been a bit 'meh' about TP-Link's firmware, and in terms of the web interface, it's still a step behind some of the competition (particularly ASUS, D-Link and Linksys). But the improved mobile apps more than make up for it, providing a slick setup

process and access to most of the router's important features, including schedule-based parental controls and USB device management. There are some you'll still need to use the web admin for; for instance, TP-Link supports PPTP/L2TP VPNs as a client, which is great, but you'll need to dive into the weeds a little to set it up.

The Archer C3150 managed to perform well in our tests, and at \$300-odd, it's significantly cheaper than the tri-band devices we've reviewed here. For most home users, that's money well saved, since they mostly won't notice the difference unless there happens to be a huge number of devices accessing the network at once.

Verdict

A great balance between price and power. Most users will not need the overkill of tri-band solutions.



Wireless: 1,300Mbps AC, 450Mbps N (using 3x3 MIMO);
WAN ports: one Gigabit Ethernet port; LAN ports: four gigabit ports;
USB: none



\$550 FOR KIT (\$250 FOR STAND-ALONE ROUTER)
AMPLIFI.COM

Ubiquiti AmpliFi Mesh Wi-Fi System

An elegant mesh network.

Not only does the Ubiquiti AmpliFi look cool, with its white cube design and a visual display of network speeds, but it's also one of the most elegant mesh solutions available.

We looked at the Mesh Wi-Fi system, a kit that contain both the AmpliFi HD Mesh Router and a pair of AmpliFi HD Meshpoints – antennae/extenders that plug directly into a power socket and sit flush with the wall. You set up the router wherever your internet comes in, then place the two mesh points where you need to extend coverage. Both the router and the mesh point support 3x3 MIMO up to 1,300Mbps, and the router also contain four Gigabit Ethernet ports (but no usable USB ports).

For setup, a supplied app uses Bluetooth to talk to the router and mesh points, providing a load of speed and network diagnostic info. We really loved how easy it was to get running, although we'd be leery of

using the HD Mesh Router as a primary router since it simply doesn't have many of the more advanced tools found in other units (forget DLNA, USB storage, parental controls, QoS and the like). You can set it to bridged mode to turn off routing functions.

In addition to the testing directly to the router with no mesh points plugged in (the results listed in table), we also tested the network with a mesh point placed at 10m from the router and 5m from the test station. The results were good, but not great – there's no dedicated back channel – at 28.3MB/s, less than half the speed of connecting directly to the router at 5m, ahead of directly connecting to the router at 15m. ■

Verdict

A great system for providing mesh Wi-Fi coverage, but not a great router.



Connecting to the NBN: what to expect

Confused about what's involved with getting the NBN hooked up? Nathan Taylor outlines all the essential info you need to know.

So you've checked the rollout map at nbnco.com.au and now know when you'll be getting the NBN. So now you'd like to know how this whole thing works, what you'll need and what you'll have to do to set it up.

The answer to that really depends on what flavour of NBN you'll be getting. There are six possibilities, and unfortunately, the rollout map doesn't presently break it down by type other than fixed line vs wireless.

You can make a guess: most of the areas currently covered by the rollout map are fibre to the premises/home (FTTP) since that's mostly the tail end of the original Labor NBN plan. If you can currently get Foxtel or Optus cable TV in your area, you'll probably be getting hybrid fibre coax (HFC). If you can currently get ADSL 2+ (but not cable or fibre), you'll probably end up on fibre to the node (FTTN) or fibre to the building (FTTB) in the case of unit blocks. And if you're currently wireless, you'll likely end up on either fixed wireless or satellite. Of course, these are guesses – we wouldn't recommend going out and buying equipment pre-emptively based on these assumptions!

So how will the rollout work for each of these? We'll give you a quick breakdown.

FIBRE TO THE PREMISES

With FTTP, most of the equipment needed is built into the box that gets attached to your house during installation. All you will need is a generic broadband router with a gigabit Ethernet WAN port (many current DSL routers also have a gigabit Ethernet WAN port and can indeed be used with FTTP).

The installer will attach a utility box to the outside of your house as well as a connection box and power unit inside your home. The connection box has a gigabit Ethernet port on it (called UNI-D). It's into this that you plug an Ethernet cable and connect it to the WAN port on your broadband router. The broadband router just uses DHCP for configuration, which is the default setting on most such routers.

FIBRE TO THE NODE / FIBRE TO THE BUILDING

FTTN and FTTB look and work a lot like ADSL. No new equipment is installed in your home and nobody needs to visit your premises. Your current phone line will remain your link to the internet.

There will need to be one change on your end. Your old ADSL router won't cut it anymore. You'll need a modem router with support for VDSL2, the updated DSL standard being used for FTTN. Many newer ADSL routers also support VDSL, but older routers do not.

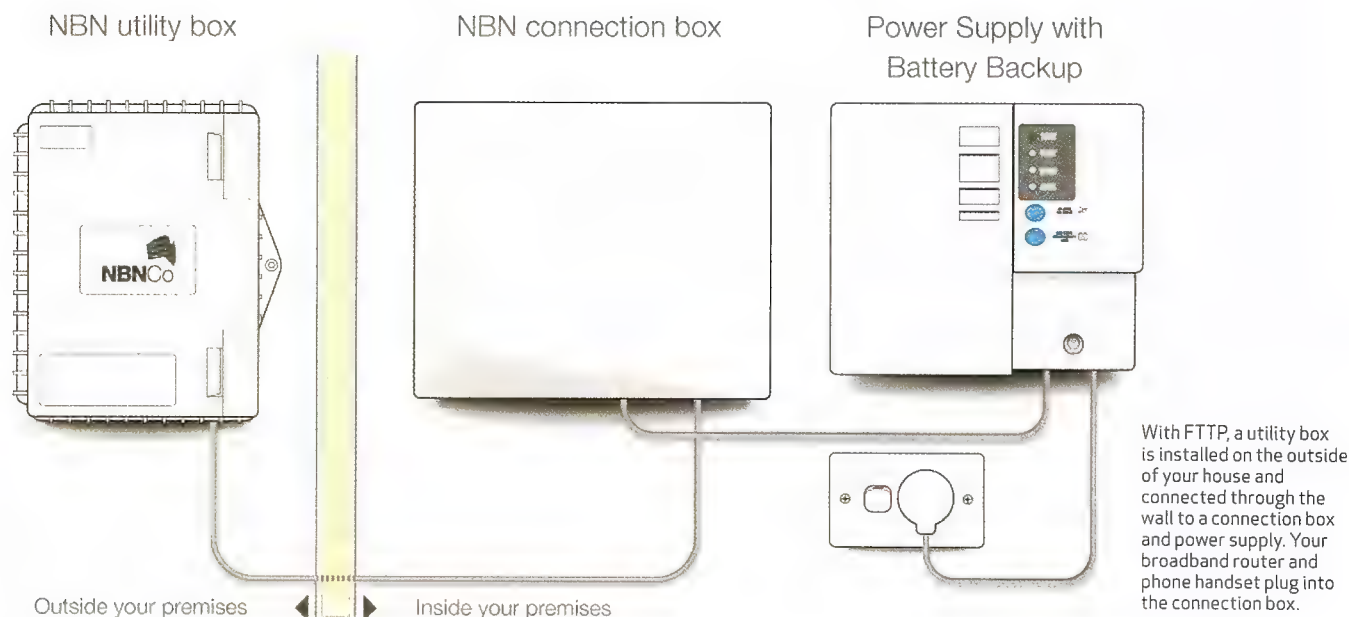
HYBRID FIBRE-COAX

If you currently have HFC connected to your home, there won't need to be any changes or anybody coming into your house. If you've never had cable TV or cable internet, however, an installer will need to come in and set it up. Typically, a wall plate will be set up into which a coaxial cable can be plugged.

If you don't currently have a cable modem router, you will need one, which you'll be able to purchase from your ISP. You can't use a generic broadband router. There are plans to upgrade the cable network in 2017/2018, which might again require a new router.

FIXED WIRELESS AND SATELLITE

Much like FTTP, an installer will need to come to your house and install equipment, which will include a connection box and a satellite dish or fixed outdoor antenna. You connect to that equipment with a general broadband router (as with FTTP). ■





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MUST-HAVE
ON YOUR GADGET WISHLIST?

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Go further and faster: expanding & extending your network

Boost the performance of your existing network with a wireless range extender, powerline Ethernet device or faster Wi-Fi adapter for your PC. Lindsay Handmer shows you how.

These days, most home and offices are filled with all sorts of network connected devices, often all competing for bandwidth. Wi-Fi is very convenient, but isn't suitable in all situations, and can struggle in larger houses. Many people are still using the (often outdated) Wi-Fi router supplied by their ISP, but there are loads of better options available.

The increasing popularity of high-definition (HD) media streaming also puts more pressure on home networks – especially those with families who all want to watch their own show at the same time. For those not lucky enough to have hard-wired Ethernet in every room, there are loads of different ways to get the best speeds. The latest spec USB and PCIe Wi-Fi cards can actually be as fast as a wired connection, thanks to all sorts of clever MIMO tricks and multiple antennas. For those who want or need wired stability without

a permanent install or messy cables (such as people renting a house or unit), powerline adapters create a plug and play wired connection over existing electrical wires – though are not without their own setup quirks. Other devices can do double or triple duty, as powerline adapters with Wi-Fi, or range extenders that can function as access points or be configured as a media bridge.

To provide a more in-depth look at all the available options and devices, as well as their real world performance, we benchmarked eight powerline networking kits, eight PCIe and USB Wi-Fi adapters and four Wi-Fi range extenders. We focused on real world throughput and range – don't believe all the claims on the box!

Wi-Fi range extenders

WI-FI IS VERY CONVENIENT, BUT LOADS OF FACTORS CAN DEGRADE THE SIGNAL AND GIVE POOR BANDWIDTH, OR AN UNRELIABLE, HIGH PING CONNECTION.

Many houses end up with an annoying black spot, and maintaining a link into a backyard or garage can be a frustrating experience. Wi-Fi range extenders step in to help by picking up an existing signal, and re-broadcasting it, to increase the overall range. For a device connecting to the network, the switch between the two complementary networks is automatic and seamless. Some models also have a LAN port, and can extend a wired network, over Wi-Fi. Others can be configured as media bridge, to bring wireless connectivity to wired only devices such as a gaming console.

It is important to match the range extender to your existing Wi-Fi. The spec is usually given as the Wi-Fi standard supported (N or AC), and the total throughput in megabits per second (Mbps) – for example, AC1900 means 802.11ac spec, with a theoretical total of 1,900Mbps throughput split across both 2.4GHz and 5GHz frequencies. (Specifically, 600Mbps on the former and 1,300Mbps on the latter.)

HOW WE TESTED

Wi-Fi range extenders were connected to our test network, using a Linksys EA9500 or compatible router. Each was positioned for the best signal strength, around halfway to the 'edge' of the main network. Throughput was tested at a further 10m range, beyond a useful connection to the original Wi-Fi. Speeds were measured with LAN Speed Test. The extenders were configured to just repeat the signal on both frequencies, and not link back to the router on the other band. This reduces overall bandwidth, but ensures both 2.4GHz and 5GHz devices can connect.

LABS BENCHMARK RESULTS

2.4 GHZ DOWNLOAD /
UPLOAD (MBPS)

167 / 158

5GHZ DOWNLOAD /
UPLOAD (MBPS)

389 / 358



\$219 | WWW.ASUS.COM/AU

AC1900 802.11ac Wi-Fi; 1,300Mbps @ 5GHz,
600Mbps @ 2.4GHz; 1x USB 3.0;
5x Gigabit Ethernet

ASUS RP-AC68U

A seriously high-end range extender.

Unlike some of the slimline options, the ASUS RP-AC68U is a stylish, yet chunky and elongated cube, measuring in at 178 x 106 x 106mm. It uses the extra space to hide 4 internal MIMO antennas that are designed to cover large areas. It also has five Gigabit LAN ports, accommodating wired devices.

The AC68U IS AC1900 spec, so can handle 600 Mbps on the 2.4GHz band, and 1300Mbps on 5GHz. Getting set up is fast and easy with a WPS button, and LED indicators help to fine tune positioning for best signal strength. The repeater also has a USB 3.0 port, which can turn your storage devices into a NAS, and is remotely accessible via the AiCloud app. The RP-AC68U had no problem extending our Wi-Fi out beyond the range of the original router, and gave a big speed boost under the test conditions.

The AC68U operates as a Wi-Fi range extender by default, but can also be switched to work as an access point, or media bridge.

Verdict

A very high-speed range extender packed with handy extra features.



LABS BENCHMARK RESULTS

2.4 GHZ DOWNLOAD /
UPLOAD (MBPS)

59/61



\$45 | WWW.DLINK.COM/AU

802.11n Wi-Fi, 300Mbps @ 2.4GHz; USB powered;
WPS button

D-Link DMG-112A

A range extender with a difference.

Unlike the larger mains-powered options, the D-Link DMG-112A opts to be very compact and USB-powered. Important to note, the D-Link extender is 2.4GHz 802.11n only, and has a maximum throughput of 300Mbps. Its antennae are internal as well, so its range is comparatively limited.

In real-world testing, though, it easily helped counter dead zones and brought a strong signal to our backyard. Real-world speed is also fairly low, but keep in mind that it's specifically designed to be low-cost, low power use and very portable. The DMG-112A has a WPS button for quick setup, but is otherwise configured through a free D-Link app. The unit does come with a mains USB power adapter which, when coupled with a USB extension cable, makes it really easy to position the unit in the ideal location.

We also ran it directly from a USB power bank – a perfect option for temporarily boosting Wi-Fi outdoors.

Verdict

If you don't need high-bandwidth streaming, this older, well-priced device offers an inexpensive way to extend 802.11n Wi-Fi.



LABS BENCHMARK RESULTS

2.4 GHZ DOWNLOAD / UPLOAD (MBPS)	5GHZ DOWNLOAD / UPLOAD (MBPS)
77 / 65	298 / 270



\$200 | WWW.LINKSYS.COM/AU

AC1900 802.11ac Wi-Fi, 1,300Mbps @ 5GHz, 600Mbps @ 2.4GHz; 1 x Gigabit Ethernet; access point mode

Linksys RE7000

Extension for high-speed networks.

Based around the AC1900 spec, the RE7000 can manage 600 Mbps on the 2.4GHz band and 1300 Mbps on 5GHz. It uses MU-MIMO tech, so is ideal for providing multiple users with maximum speed. The unit is also designed to be very simple, with internal antennas, a WPS button, and an app-guided setup. The RE7000 also goes a step further, with a single Gigabit Ethernet port, which feeds the network connect out to a wired-only device. Alternatively, plug it into a wired network, and configure it as a high speed Wi-Fi access point.

While the RE7000 is backwards-compatible with older networks, to get full speeds a fairly modern Wi-Fi router is needed. It'll plug directly into a 240v socket, but we used a short extension cord, and tucked it away (standing vertically) on top of a book shelf for a better position. This allowed it to dramatically improve both the range and throughput of our network.

Verdict

A simple yet effective way to extend your high speed network.



LABS BENCHMARK RESULTS

2.4 GHZ DOWNLOAD / UPLOAD (MBPS)	5GHZ DOWNLOAD / UPLOAD (MBPS)
74 / 81	211 / 233



\$140 | WWW.NETGEAR.COM/AU

AC1200 802.11ac Wi-Fi; 867Mbps @ 5GHz, 300Mbps @ 2.4GHz; 1 x Gigabit Ethernet; access point mode

Netgear EX6150

High end but still surprisingly affordable.

Instead of going for all-out speed, the Netgear EX6150 dials it back a bit, using the AC1200 spec. That's still pretty fast, with up to 300 Mbps on the 2.4GHz band and 900 Mbps using 5GHz. It also uses Netgear FastLane Technology, which can configure one band to only talk to the router (like a media bridge), while the other band connects to your devices. On the side, the EX6150 has a Gigabit Ethernet port, which can be used to connect to wired only devices, or allow the unit to work as an access point. It also has a WPS button for easy connections, and dual adjustable antennas.

In normal use, the EX6150 does an excellent job of improving range and throughput, but the direct 240v socket plug-in can be both inconvenient and handy. If using FastLane and 2.4GHz to link back to the router, bandwidth is reduced, but the better penetrating power of the lower frequency band means the range extender can be plugged in further away.

Verdict

While not the highest speed, the included FastLane tech is useful for long range wireless links.



LABS BENCHMARK RESULTS

2.4 GHZ DOWNLOAD / UPLOAD (MBPS)	5GHZ DOWNLOAD / UPLOAD (MBPS)
79 / 60	101 / 98



\$70 | WWW.TP-LINK.COM/AU

AC750 802.11ac Wi-Fi, 433Mbps @ 5GHz, 300Mbps @ 2.4GHz; 1 x Gigabit Ethernet port; media bridge mode

TP-Link RE210

Affordable and effective.

Operating at a slower AC750 spec, the TP-Link RE210 is good for 300 Mbps on the 2.4GHz band and 433 Mbps on the 5GHz band. To put it in context, the range extender is only \$70, so is aimed at everyday networks, rather than those who need the absolute highest throughput. The RE210 uses dual, adjustable external antennas, and has an LED signal meter to help find the best position. It also has a WPS button, and can switch the indicator LEDs off for use at nighttime. Underneath, it also has a Gigabit LAN port (and comes with a cable), so can connect your wired devices to the network. The RE210 also has a High Speed Mode, which uses one band to send data, and the other to receive it, and works a bit like a media bridge.

While the RE210 doesn't achieve the same level of throughput as more expensive repeaters, it did an excellent job of extending out our existing network. Like many repeaters, it plugs into a 240v socket.

Verdict

A low cost way to extend your dual band wireless network.



Powerline adapters

GET THE SECURITY AND STABILITY OF A WIRED NETWORK WITHOUT HAVING TO RUN CABLES.

Powerline adapters transmit network data via existing electrical wiring, as an alternative to Wi-Fi, or having to install Ethernet cables – fine if you want to go behind your brickwork or have cable hugging your walls, but a hassle nonetheless. Installing a powerline adapter is fast and easy, no physical changes are needed, wireless interference is avoided, and they are fairly affordable.

That said, there are quite a few important factors to consider before buying a Powerline setup. Many units come in a kit of two, but some are sold individually. Other models can have extras, such as a built in Wi-Fi access point, or a mini Ethernet switch. While the maximum speeds listed are quite high (exceeding Gigabit Ethernet in some cases), real world speeds are typically much much lower. While some can work across phases, adapters can generally only communicate with units plugged into the same circuit. Powerline units are still subject to interference from other appliances, and use with plug boards or surge protectors should be avoided. Most units comply with HomePlug standards, so cross brand compatibility is possible, but not guaranteed.

If in doubt, make sure you buy from a retailer with a good return policy, in case the Powerline adapters don't give the desired results.

HOW WE TESTED

PowerLine adapters were connected to circuit sharing with other electronic appliances, such as a TV and modem. Speed was tested with approximately 7m between the adapters, each plugged directly into the socket. Throughput was tested with LAN Speed Test, between two Gigabit Ethernet connect PCs.

LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
168	162



\$120 | WWW.DLINK.COM.AU

1,000Mbps, max 16 adapters, backwards compatible

D-Link DHP-601AV

Get connected.

With two units in the one pack, the D-Link DHP-601AV is aimed at those wanting to create a high speed network, and is rated for 1000 Mbps, ideal for streaming media and large file copies. Each unit has a single Gigabit Ethernet port, and comes with cables. If you already own a D-Link PowerLine product such as the AV500, the faster model is fully backwards compatible. You can also add up to 16 of the adapters, for really big networks.

Setup is as easy as plugging them in and pressing the configure button. Handily for your power bill, and the environment, the adapters have a power saving mode which reduces consumption by up to 85%.

The D-Link units plug directly into the socket, have a slight spacer, and are fairly slim, so don't block other ports. In testing they performed quite well, and we managed speeds of 168 / 162 Mbps, uploading and downloading data. The \$120 price tag is also pretty good, all things considered.

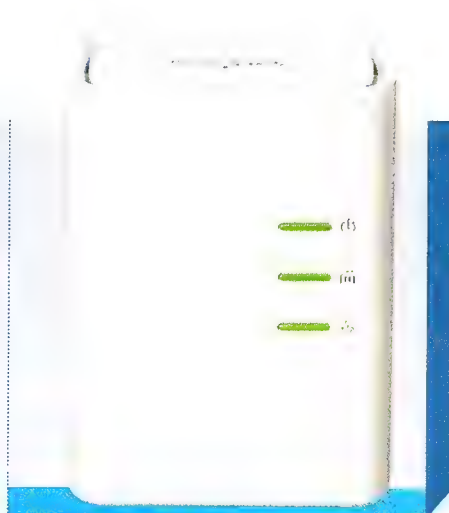
Verdict

An easy and affordable option for Gigabit networks.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
67	64



\$79 | WWW.DLINK.COM.AU

500Mbps throughput, max 16 adapters, backwards compatible

D-Link DHP-309AV

A mini starter kit.

Designed for less-demanding needs, the D-Link DHP-309AV adapters are rated for up to 500 Mbps throughput. The starter kit consists of two units, each with a 10/100 Ethernet port on the bottom, plus a cable in the box. Setup is very simple – plug the devices in, and hit the configuration button. The adapters automatically connect, and use 128-bit encryption to keep your data safe from snooping. While slower than the D-Link AV2 1000 adapters, the AV500 kit is cross compatible for future upgrades. In total, you can install up to 16 adapters, for wired networking in every corner of a house. It also has built-in power savings, reducing consumption by up to 70%. The units also use a QoS engine to analyse and separate the transmitted data, to ensure important traffic is given priority.

In real world use the compact D-Link kit managed an acceptable 67 Mbps up, and 64 Mbps down. A spacer also helps them sit above other plugs.

Verdict

Decent speeds and features without blowing the budget.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
87	81



\$55 (PER UNIT) | WWW.EDIMAX.COM

500Mbps; 3-port 10/100 switch; 16 devices total

Edimax HP-5101ES

An upgraded powerline adapter.

The Edimax HP-5101ES bucks the trend and is sold per device, not in a kit of two. Fine, as Edimax has quite a range of different adapters, which can be mixed and matched to create the perfect setup. Instead of a single Ethernet connection, the HP-101ES incorporates a three-port 10/100 switch. This makes for a more affordable, and easier, way to plug multiple devices into the one socket, without needing extra hardware. So, it's perfect for connecting a TV, media player, and console to the network.

The HP-5101ES uses the AV500 spec for speeds up to 500 Mbps. It's compatible with other HomePlug 1.0 devices (including AV200 spec), and Edimax adapters. In testing, we hit speeds of 87 / 81 Mbps, up and down. While slower than Gigabit spec devices, it's fast enough for normal network use.

The HP-5101ES has built in 128-bit security, noise filtering, IGMP managed multicast streams and a power saving mode if not in use.

Verdict

A versatile option for those who don't need Gigabit speeds.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
82	79



\$60 (PER UNIT) | WWW.EDIMAX.COM

500Mbps; 802.11n Wi-Fi; 1 x 10/100 Ethernet

Edimax HP-5102Wn

Wired and wireless, together at last.

In an effort to get the best of both worlds, the Edimax HP-5102Wn squeezes a Wi-Fi access point into the powerline adapter. This makes it easy (and affordable), to install a wired connection in a room that's a gulf away from the router, but also allows for wireless connections. The PowerLine side of the adapter is rated at AV500 spec, for speeds up to 500 Mbps, and has a single 10/100 Ethernet port. The built in Wi-Fi access point is 802.11n spec, with two internal antennas, and can handle speeds up to 300 Mbps.

The HP-5102Wn is sold as a single device rather than a kit of two, but is compatible with other Edimax and HomePlug 1.0 devices. This means the Edimax Powerline adapters can create a versatile network, without needing extras such as Wi-Fi access points.

In real world speed tests, the HP-5102Wn is on par with its compatriots, managing 82 and 79 Mbps, up and down. At 2m (in the same room), we peaked at 65 Mbps from the Wi-Fi.

Verdict

A great way to include a Wi-Fi access point on a Powerline network.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
89	82



\$120 | WWW.NETCOMM.COM.AU

500Mbps; 1 x 10/100 LAN port; HomePlug 1.1 compatible

NetComm NP511

A powerline upgrade kit.

The NetComm NP511 kit includes two devices, each with a single 10/100 Gigabit Ethernet port on the bottom, and is rated for speeds up to 500 Mbps. The adapters pass the AC power through, and a spacer on the underside means it can co-exist with other plugs.

The NP511 is HomePlug 1.1 compatible, but NetComm recommend not mixing brands. The units have built in noise filtering, and an automatic power saving mode when not in active use. Up to 15 can be connected together into a single network.

The NP511 managed better throughput (89 / 82 Mbps up and down) than any other AV500 spec adapter we tested, but not by a huge margin. One nice touch is a green, amber, red LED to indicate connection speed, from best to worst. It also has a button for one touch security, to avoid any data being accessible externally.

The NP511 competes with faster 1000 Mbps products but doesn't add any extra functionality.

Verdict

A touch pricey for 500Mbps speeds, but with plenty of features.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
178	174



\$95 | WWW.NETGEAR.COM.AU

1,000Mbps; Max eight adapters; Homeplug AV2 compliant

Netgear Powerline 1000

High speed connectivity without extra wires.

For those with demanding network needs, the Netgear PL1000 is rated for up to 1000 Mbps throughput. Each unit in the kit of two has a single Gigabit Ethernet port, and comes with a 2m cable. The PL1000 kit is AV2 HomePlug compliant, so is cross compatible with devices that use the same spec. It's also backwards compatible with HomePlug AV1.0, and can co-exist (but not cross communicate) with HomePlug 1.0 devices sharing the same circuit. Netgear recommends no more than eight PL1000 adapters should be used at once on the same circuit.

Slightly wider than some, the PL1000 uses a spacer to sit out far enough that most normal plugs can use the next socket. When not connected, the unit powers down to save electricity. Setup is easy – plug them in, hit the button to secure the network.

The PL1000 managed excellent speeds of 178 / 174 Mbps up and down, and has a multicolour LED indicator to help find the best connection speed.

Verdict

Recent price drops make this one of the best Gigabit Powerline kits available.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
221	219



\$125 | WWW.TP-LINK.COM.AU

1,200Mbps; Gigabit Ethernet; 2x2 MIMO

TP-Link TL-PA8010P

Feel the need for speed.

Supporting the latest HomePlug AV2 spec, the TP-Link TL-PA8010P uses 2x2 MIMO tech and all three power wires to offer speeds of up to 1200 Mbps. It also means the system can handle longer ranges better, and offer a connection in places lesser devices won't. Each adapter has a single Gigabit Ethernet port, and the kit comes with dual 2m cables. The TL-PA8010P devices are fully backwards compatible with slower AV spec adapters, down to AV200 – though run at the speed of the slowest unit.

Installing the TP-Link adapters is very simple – just plug them in, and hit the button to pair the units and enable 128-bit security. While the rated 1200 Mbps speeds is more than the Gigabit Ethernet port can handle, in real world testing the adapters managed 221 Mbps up, and 219 Mbps down. That's still faster than any other PowerLine device tested, and a fantastic result. While this kit has a higher price tag than others, it's worth the extra cost.

Verdict

Fast and feature packed yet still a very affordable powerline.



LABS BENCHMARK RESULTS

DOWNLOAD (MBPS)	UPLOAD (MBPS)
71	69



\$109 (KIT) | WWW.TP-LINK.COM.AU

500Mbps; 802.11n Wi-Fi; wireless cloning

TP-Link TL-WPA4220

Linking your wired and wireless worlds.

Squeezing a Wi-Fi access point into the Powerline adapter, the TP-Link TL-WPA4220 makes it easy to bring both a wired and wireless connection to remote corners of a house. The units are rated for speeds up to 500Mbps, using the HomePlug AV standard and a 10/100 Ethernet port. The Wi-Fi half is 802.11n only, and good for up to 300 Mbps. They are also fully compatible with other HomePlug AV spec devices.

Back in the real world, we managed 71 / 69 Mbps up and down, and a maximum of 59 Mbps on Wi-Fi, in the same room. Setup is the usual plug-in-and-press-the-pair-button, which also turns on 128-bit security. To make extending your existing Wi-Fi easier, the adapters have a Wi-Fi clone button, which copies the existing router configuration and is good to go. They also have a three colour LED, which indicates the quality of the network connection at the current location.

\$109 gets you a twin adapter kit, or you can pay \$69 for an individual unit.

Verdict

Making it simple to add Wi-Fi to your existing Powerline network.



USB & PCIe Wi-Fi adapters

REV UP YOUR LAPTOP OR DESKTOP'S WIRELESS CAPABILITIES WITH AN 802.11AC WI-FI ADAPTER.

Wi-Fi can be a great way to connect a multitude of devices to a network with little fuss. But in a world with increasing demand for high bandwidth media streaming and the ability to handle large files, real-life speeds can be a letdown.

Updates to the 802.11ac Wi-Fi standard mean that many new devices can use all sorts of techniques to maximise throughput. While 2.4GHz generally gives longer range and better wall penetration, 5GHz networks support high bandwidths. To help bring older computers up to date, we've tested a bundle of the latest 802.11ac spec USB and PCIe Wi-Fi adapters.

USB models can be a simple way to upgrade the existing Wi-Fi on a laptop (or desktop) with no in-depth install needed. Some models can be very compact, while others sport large antennas. USB adapters can also be connected via a USB extension cable, so can be positioned away from the computer for the best reception. PCIe adapters are often available in higher speeds, with an array of antennas for better reception.

HOW WE TESTED

Wi-Fi adapters were connected to a Linksys EA9500 router on the 5GHz band, and tested indoors at 1m range with no obstructions, then at a 10m range, with three walls in between. Network speeds we measured with LAN Speed Test, between two computers.

Note that some high-speed wireless connections are bottlenecked by the Gigabit Ethernet at each end. As a comparison, a wired Ethernet connection tested at 919/903Mbps up and down.

LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD /
UPLOAD (MBPS)

899 / 812

10M RANGE DOWNLOAD /
UPLOAD (MBPS)

692 / 547

LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD /
UPLOAD (MBPS)

821 / 714

10M RANGE DOWNLOAD /
UPLOAD (MBPS)

421 / 364



\$159 | WWW.ASUS.COM/AU

Half-height PCIe card; AC3200 802.11ac Wi-Fi; 2,167Mbps @ 5GHz, 1,000Mbps @ 2.4GHz; extension antenna station included



\$109 | WWW.ASUS.COM/AU

USB 3.0 adapter; AC1900 802.11ac Wi-Fi; 1,300Mbps @ 5GHz, 600Mbps @ 5GHz; extension cable included

ASUS PCE-AC88

For blazing fast Wi-Fi.

For those who crave the ultimate wireless performance, the PCE-AC88 is ready to deliver. Built on the PCIe form factor, the network card has four send/receive antennae, making it AC3100 spec. In other words, it can handle a massive 1,000Mbps on 2.4GHz and 2,167Mbps on 5GHz. There are a few caveats, of course – you will need a compatible 4x4 router, and the unit won't work at full speed if it can't spread out and operate over multiple Wi-Fi channels. In real-world testing, the AC88 is crazy fast, and in fact limited by the Gigabit network on the other end of our test. At longer range, the Wi-Fi adapter maintained impressively high speeds that were almost on par with Gigabit Ethernet.

The AC88 uses a half-height PCIe card, with chunky integrated heatsink. While the antennae can be mounted directly to the card, it also comes with a very handy base station and extension cables. It's magnetic too, which makes it very easy to position.

Verdict

Perfect for those who need Wi-Fi bandwidth that rivals a wired connection.



ASUS USB-AC68

A Wi-Fi dongle like no other.

Not content with normal reception or speeds, the ASUS boffins built a dual-band 802.11ac adapter that uses the AC1900 spec. The AC68 connects via USB 3.0, and uses a special 3x4 MIMO antenna design (three transmit, four receive), with two fold-out antennae that can lock in multiple positions. Combined with the ASUS AiRadar software, this makes it easy to optimise the connection for maximum throughput. The device is large but quite portable, and can be plugged directly into a USB port, but is better used with the included extension cable and stand.

To achieve full speed, the AC68 needs a compatible router, and pulls up to 600Mbps from the 2.4GHz band and 1,300Mbps from 5GHz. Under the hood it has a Realtek RTL8814AU chipset.

Performance is absolutely top notch, and we hit speeds that no other USB adapter could manage. The large antennae also mean that the AC68 excelled at longer ranges.

Verdict

An easy way to upgrade your PC to extremely high-speed Wi-Fi. While much pricier than the slower competition, it's worth it.



LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD / UPLOAD (MBPS)	10M RANGE DOWNLOAD / UPLOAD (MBPS)
486 / 455	182 / 156



\$49 | WWW.DLINK.COM.AU

USB 3.0 adapter; AC1200 802.11ac Wi-Fi; 867Mbps @ 5GHz, 300Mbps @ 2.4GHz; extension dock included

D-Link DWA-182 802.11ac Wi-Fi in your pocket.

A little USB dongle, the D-Link DWA-182 packs AC1200 performance into a small form. The unit connects via USB 3.0, and comes with an extension cable and dock, which allows it to be easily positioned to get the best reception. The 182 is a bit of a cross between smaller 'nano' Wi-Fi dongles, and the larger models with adjustable antennae.

The DWA-182 can handle up to 300Mbps on the 2.4GHz spectrum and 867Mbps on the 5GHz band. In real-world testing, it struggles to get full speeds up close, but still puts on a decent show. At range, careful positioning is needed to get the best from the compact dongle. You do need a USB 3.0 connection for the fastest speeds, but it will operate on 2.4GHz using USB 2.0.

The D-Link DWA-182 measures in at 9.7 x 2.9 x 1.2cm, and weighs 9g. While not the fastest adapter, or the smallest, the DWA-182 is quite an affordable upgrade, considering it costs just \$49.

Verdict

A decent way to add AC1200 performance to just about any USB 3.0-equipped PC or laptop.



LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD / UPLOAD (MBPS)	10M RANGE DOWNLOAD / UPLOAD (MBPS)
555 / 548	214 / 186



\$79 | WWW.DLINK.COM.AU

Half-height PCIe card; AC1200 802.11ac Wi-Fi; 867Mbps @ 5GHz, 300Mbps @ 2.4GHz

D-Link DWA-582 A desktop Wi-Fi upgrade.

Using a PCIe 1x interface, the D-Link DWA-582 supports 802.11ac Wi-Fi on both 2.4GHz and 5GHz bands. The card uses dual large 4.5dBi external antennae, which can be repositioned for the best reception. By default, it has a standard height PCI adapter plate installed for normal use. For those with a mini-PC build, it also comes with a low profile plate that can be swapped into place by removing two screws.

The DWA-582 can manage transfer rates up to 300Mbps on 2.4GHz, and 867Mbps on 5GHz. Of course, in the real world, it's a whole lot less, but the Wi-Fi card can still hold its own for normal use with around 550Mbps up and down. At longer ranges, the connection speeds remain strong, as long as the antennae are on the same side of the PC as the router. If instead the computer is orientated with the rear, away from the router, the extra mass of metal and interference can drop the connection speed in half.

Verdict

A solid but not mind-blowing PCIe Wi-Fi upgrade.



LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD / UPLOAD (MBPS)	10M RANGE DOWNLOAD / UPLOAD (MBPS)
351 / 342	192 / 196



\$29 | WWW.EDIMAX.COM

USB 3.0 adapter; AC600 802.11ac Wi-Fi; 433Mbps @ 5GHz, 150Mbps @ 2.4GHz; directional antenna

Edimax EW-7811DAC A unique Wi-Fi adapter.

Almost all Wi-Fi adapters use an omni-directional antenna, to give excellent performance even when moved around. Not the Edimax EW-7811DAC, though, which uses a special directional antenna for better bandwidth. The unit is USB powered, and offers AC600 spec speeds. In this case, 150Mbps via 2.4GHz, and 433Mbps using the 5GHz band. It also comes with a USB extension cable and cradle, allowing it to be mounted in the best location.

While otherwise fairly normal, the Edimax uses a large flat directional antenna, which gives it an extra dB of gain (on both channels) compared to even a large omnidirectional antenna. The trade-off is that it needs to be aimed directly at your router.

While up close, the Edimax dongle gives similar performance to the competition, at longer range (and with some walls in the way), the directional antenna maintains much higher bandwidth.

Verdict

A very affordable way to get better performance from your older network.



LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD / UPLOAD (MBPS)	10M RANGE DOWNLOAD / UPLOAD (MBPS)
321 / 317	104 / 99



\$55 | WWW.LINKSYS.COM

USB 2.0 adapter; AC600 802.11ac Wi-Fi; 433Mbps @ 5GHz, 150Mbps @ 2.4GHz

Linksys WUSB6100M

Compact and portable.

The little Linksys AC600 measures in at just 37 x 6 x 5mm, and weighs 6g – about the same as a USB drive. Hidden inside is a marvel of compact 802.11ac Wi-Fi connectivity, with both 2.4GHz and 5GHz frequencies supported. The little dongle only needs USB 2.0 as well, so is compatible with older systems. The 5GHz side can handle speeds up to 433Mbps, while the 2.4GHz band manages 150Mbps. Despite lacking external antennae, it still features MU-MIMO and beamforming, to improve the connection when used at the same time as other Wi-Fi devices.

The Linksys dongle is respectably fast when close to the router. At longer ranges, the tiny internal antennae mean walls and other obstructions quickly eat into the throughput. This is particularly noticeable when using the 5GHz band.

Thankfully, the Linksys dongle is quite affordable, and makes a great upgrade for older devices – at least if long range is not the focus.

Verdict

An easy and compact way to upgrade your Wi-Fi via USB.



LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD / UPLOAD (MBPS)	10M RANGE DOWNLOAD / UPLOAD (MBPS)
613 / 604	256 / 221



\$65 | WWW.NETGEAR.COM.AU

USB 3.0 adapter; AC1200 802.11ac Wi-Fi; 867Mbps @ 5GHz, 300Mbps @ 2.4GHz; adjustable antenna

Netgear A6210

A versatile AC1200 option.

Unlike lesser USB Wi-Fi dongles, the Netgear A6210 uses a large adjustable antenna, for better throughput and reception. The unit is an upgrade to the older (also excellent) AC6100 adapter, which used the same AC1200 spec. The new unit looks very similar, but is a tiny bit smaller at 9.3 x 3.1 x 1.4cm and weighs slightly more, at 28 grams. The unit also has a USB extension cord and dock for the dongle, which allows it to be positioned in the best location to maximise reception.

The A6210 is a dual band 802.11ac, with the 2.4GHz side rated to 300Mbps, and the 5GHz good for 867Mbps. In real-world testing, speeds are slower of course, but the A6210 puts on a good show, and outperforms smaller USB adapters at long range. The dongle needs USB 3.0 for full speed, but is backwards compatible with USB 2.0, and even 1.1, god forbid.

While the older model is still available, the A6210 is significantly more affordable, and a solid purchase.

Verdict

An upgraded model for long range, high speed USB Wi-Fi connection.



LABS BENCHMARK RESULTS

1M RANGE DOWNLOAD / UPLOAD (MBPS)	10M RANGE DOWNLOAD / UPLOAD (MBPS)
772 / 709	322 / 331



\$89 | WWW.TP-LINK.COM.AU

Full-height PCIe x1 card; AC1900 802.11ac Wi-Fi; 1,300Mbps @ 5GHz, 600Mbps @ 5GHz; 3 x antennae

TP-Link Archer T9E

An affordable AC1900 performer.

It's common to use Gigabit Ethernet rather than Wi-Fi on desktops, for the increased speed. But the PCIe-based TP-Link Archer T9E can hit up to 1,300Mbps using the 5GHz band, and 600Mbps on the 2.4GHz band. The Wi-Fi card uses three adjustable antennae, to help make it easy to tweak for the best connection speeds. The card itself has a low profile passive heatsink to keep cool, but while fairly compact, only comes with a full height PCIe mount.

During testing, the Archer T9E is extremely fast at close range – though still not quite as good as a wired connection. At a distance, careful positioning of the antennae is needed to get the best result, but as long as the rear of the computers is aimed at the router, throughput remains strong.

Cheaper than a 1,300Mbps-capable USB Wi-Fi dongle, the T9E is also not much more expensive than a slower PCIe adapter. It also supports older Windows systems back to XP.

Verdict

A fast yet fairly affordable way to upgrade your desktop to 802.11ac Wi-Fi.



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Note: Game code is only available to redeem on/after the game release date (2017/3/7).

*Product features and specifications may vary by model.

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SPEED UP WINDOWS 10

Give Windows a shot in the arm by cleaning up and optimising your PC with Nick Peers.

Spring isn't exactly in the air, but since it's most likely cold and rainy outside, now is the perfect time to take a virtual vacuum to your computer. Each year, it's the same old story: despite your best intentions, you rapidly lose control of what goes on to your PC, as programs are installed and forgotten, while gigabytes of files — from documents to photos and videos — are copied multiple times to a myriad locations, clogging up your hard drives. The result? A computer that's slow to start, performs sluggishly and is approaching the limits of your storage capacity.

But let's say you've resolved to clean out your PC, and what better way than to bring a back-to-the-reality dose of sanity when it performed with a snake-oil tip. This is where we come in. We're going to reveal all the tips and tricks you need to get your PC properly cleaned up and ready to go. We'll send snake oil remedies, such as Registry cleaning, to focus on techniques that actually make a difference to your PC's performance.

We've split the feature into four sections, enabling you to take your cleaning as far as you wish. Don't want to dig too deep? Our light clean focuses on quick and easy ways to clean out space using only those tools provided by Windows itself. Feeling a bit braver? We introduce a couple of tools that go further than Windows does. Then we move on to tackle the problem of duplicate files, helping you preserve just the essentials, and freeing up tens (or hundreds) of gigabytes in the process.

If you're still not satisfied, we push the boat out even further with our deep clean, revealing how to balance the competing demands of your PC's resources, strip back unnecessary services and optimise older hard drives so they perform that bit quicker. The end result is a revitalised PC, one that more closely resembles the lean, mean speed machine you bought, ready and better able to face the challenges you'll throw at it over the next 12 months.

A light spring clean

Discover how much space and resources you can reclaim armed with only Windows 10's tools.

A light spring (cough, winter) clean can free up drive space and improve your PC's performance without involving any hard work or even third-party tools. Everything we feature on these two pages is done using Windows' own built-in tools, so without further ado, let's get started.

First, check your hard drive is in good working order. The quickest way to force Windows 10 to perform a complete check on your hard drive is to right-click the Start button, and choose 'Command Prompt (Admin)'.

Type `chkdsk /f /r c:` into the command prompt window, then hit Enter. You're told the drive can't be locked (because it's in use), so press 'Y', then when you next restart, Windows performs a complete check of your hard drive, attempting to correct any errors it comes across. If it finds and fixes any, you may immediately get a speed boost. Now repeat for any other drives you have attached – if you get a warning about forcing a dismount, we suggest hitting 'N', then 'Y' to run the check when you next reboot. Once your drives have been checked, it's time to begin cleaning.

REMOVE UNWANTED APPS

How many programs have you installed on your PC? How many do you still use? Now is the perfect time to go through all the desktop programs and Microsoft Store apps you have installed, cleaning out those you no longer need or use. To do this, click 'Start > Settings'. Select 'System', followed by 'Apps & features'.

All installed apps and programs are listed alphabetically – you can, however, sort by size (useful if you need to free up drive space) or installation date. Go through the list, clicking any programs you no longer

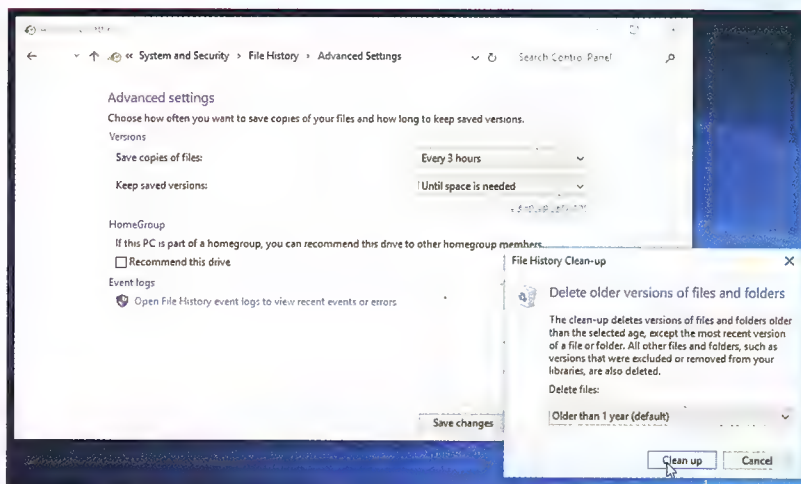
need, and choosing 'Uninstall' to remove them using the standard program installer. Some uninstallers leave Registry entries and program files behind – for a more thorough way to remove programs, turn the page.

PERFORM A DISK CLEAN

Open File Explorer, and select 'This PC' on the left to reveal a list of all your hard drives. Right-click your C drive (or the drive Windows is installed on), and choose Properties, then click the 'Disk Clean-up' button. The guide reveals how the tool works – basically, it enables you to quickly clear up all kinds of detritus, from the contents of various temporary folders to

redundant system error logs, and even older System Restore points. You can run Disk Cleanup across other drives, too, but it's usually most effective on the drive Windows is installed on.

It's worth taking a pause before simply deleting everything that Windows suggests. For example, if you've just upgraded to a new version of Windows, you should find a 'Previous Windows installation(s)' entry, offering tens of gigabytes of data ready to free up – don't select this until you're happy you won't be rolling back to that previous version (note that Windows usually deletes these files after a set time anyway; typically 30 days).

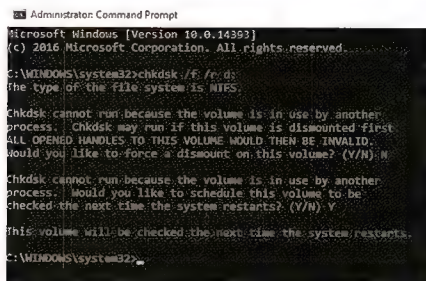


Manage Backups

Hopefully, you're making good use of File History or Windows Backup to ensure your critical files are kept safe and sound. Both methods store multiple versions of your backups, giving you the option of rolling back the changes with individual files should you wish to restore an earlier version.

This protection comes with a price, however – increased consumption of drive space. If you're feeling the squeeze, reclaim some breathing room by removing the oldest backups. Right-click the Start button and choose Control Panel. File History users should click 'Save backup copies of your files with File History', then click 'Advanced settings'. You can change the frequency of backups (to reduce drive consumption going forward), plus set a time limit for how long backups are kept ('Until space is needed' is safest, but you can specify your own time). Click 'Clean up versions' to clear out space by choosing what backups to delete (anything from all but the most recent to those backups older than two years).

If you use the Windows Backup tool, select 'Back up and Restore (Windows 7)' and click 'Manage space', then 'View backups' to manually select which backups to remove. Remember that older backups may contain files you have subsequently deleted, so be sure you haven't mislaid any critical old files before cleaning up.

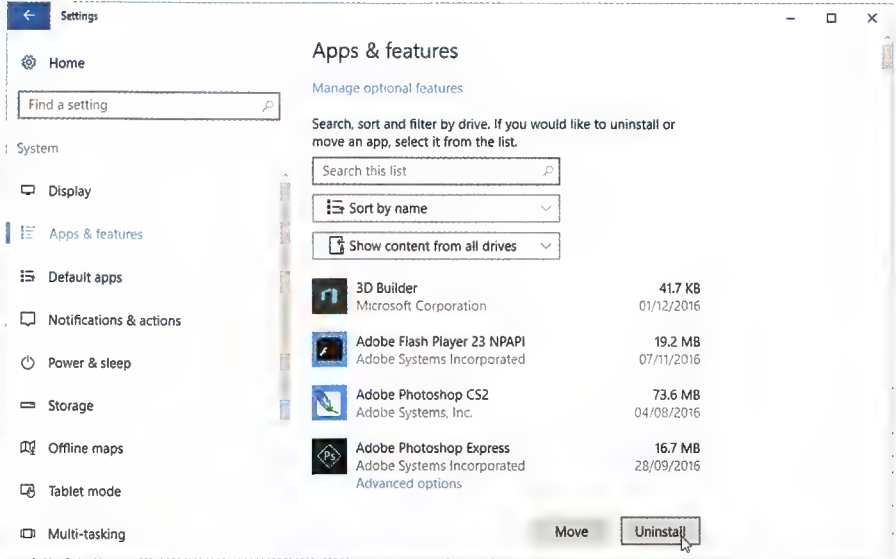


Before embarking on your cleanup, make sure your drives are error-free.

Recently installed a new driver and not sure whether it's causing problems? Don't touch 'Device driver packages', otherwise you lose the 'Roll back' option in Device Manager. Finally, if you're in the middle of troubleshooting a problem using a tool such as WhoCrashed (www.resplendence.com), deleting the 'System error memory dump files' is not recommended until you've finished fixing your problem. Long story short: Make sure you read the description of each setting before choosing whether or not to delete it, and if in doubt, leave it for now.

TRIM STARTUP ITEMS

One of the biggest bottlenecks of PC performance is the number of processes and programs running in the background. We look at more extreme ways of bringing these under control later on in the feature, but for now, the most effective way to give your PC a shot in the arm is to review the programs that start with your PC. The simplest way to do this is right-click the taskbar and choose Task Manager. Click 'More details', if necessary, then switch to the Startup tab. You'll see a list of programs set to load with Windows, complete with publisher, status (enabled at this point) and startup impact. This latter column helps you quickly determine which are the biggest resource hogs. Some programs are – by necessity – vital to the well-being of your PC, while others may be required on a regular basis, such as OneDrive or your cloud sync provider. Others, however, can be safely disabled, so they only run when you want them to. To do this, right-click the offending entry and hit 'Disable'. It'll shave seconds off your startup,



Windows 10's uninstall tool covers both desktop programs and Microsoft Store apps.

free up memory and other resources, and if you find enough items to disable, could make a noticeable difference to the performance of your PC. Don't recognise an entry? Right-click it, and choose 'Search online' to search the web for the underlying file name. Disabled entries can be restored later – right-click, 'Enable' – but if you'd like to remove them completely, explore the program's settings or preferences for an option to do so, and they should vanish from sight.

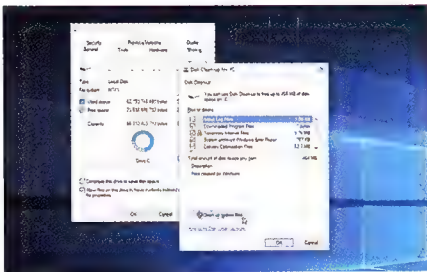
MORE CLEANUP TWEAKS

One way to improve performance is to take control of the Windows search index. This database helps speed up searches on frequently accessed folders, by scanning them for content, and storing them in a database. Sometimes, you'll want to add folders

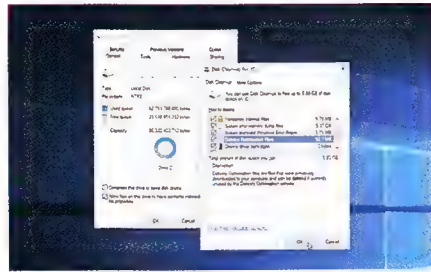
to this index – data folders stored outside your user folder, for instance – while removing others. To manage these settings, type "indexing" into the Search box and click 'Change how Windows searches'. Click 'Modify' to choose which folders get indexed, by selecting or unselecting them, or click Advanced, where you can change the index location (handy if you'd like to store it on another partition for retrieving after a Windows reinstall), or switch to the 'File Types' tab to choose exactly which sort of files you want to include in your index. This latter tip enables you to tune the search index to only find specific document or image types. If you're left feeling dissatisfied by your light spring clean, turn the page to dig a little deeper.

Free up drive space with Disk Cleanup

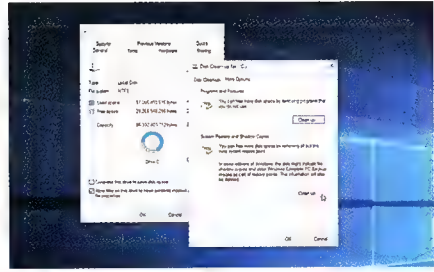
Separate the junk from the jewels, then mop up.



1 CHOOSE FULL SCAN The first time you run Disk Cleanup, you're prompted to wait while it analyses selected parts of your system. When the scan completes, you're shown an amount of disk space you can gain. For a more thorough scan, click the 'Clean up system files' button, and wait while the scan repeats.



2 REVIEW SCAN ITEMS You should find Windows has found lots more free space it can clear. Review each item by highlighting it for a description. You can select or unselect boxes to add or remove items to be cleaned – you should see the space gained figure adjust. Ready to clean? Click 'OK > Delete Files'.



3 MORE ITEMS TO CLEAN If you have System Restore enabled, you can launch Disk Cleanup again and click 'Clean up system files' for a second time. Switch to the 'More Options' tab, and quickly wipe all but the most recent Restore points by clicking the relevant 'Clean up' button after reading the warnings.

A medium spring clean for your PC

Need to free up more resources? With third-party tools, you can give Windows a more thorough clean.

Dissatisfied with the results of spring cleaning with Windows' own tools? Time to go further. In this section, we'll perform a deeper clean on areas already covered, with the help of free third-party tools, which can also reach areas not touched by Windows. As always, caution should be your keyword. While cleaning out gigs of data is satisfying, it can lose its allure if you've been hasty and discover useful shortcuts, such as the Jump lists of programs, have been removed.

REMOVE APPS THOROUGHLY

Standard program uninstallers tend to be conservative, leaving lots of detritus behind. This can soon mount up, and while you could employ the services of a Registry cleaner, the best time to clean up after a program is when you remove it.

Our tool of choice for cleaning out old programs is IObit Uninstaller (www.iobit.com/en/advanceduninstaller.php), which offers a "powerful scan" feature after a program's standard uninstaller finishes. This roots out leftover files and Registry entries, which you review and decide whether or not to keep.

During installation, look out for prompts to install Advanced SystemCare Free – it's from IObit, it's safe, but not needed for this feature. Once done, Uninstaller launches and you'll see a list of desktop programs. A number of options appear on the left, from 'All Programs' to 'Large Programs' and 'Infrequently Used'. The latter is good for weeding out the ones you're not using.

You'll see a bin button appear on the right of each program – click it to uninstall. IObit Uninstaller offers to take a System Restore point before uninstalling, which we recommend for safety purposes. It then invokes the program's own uninstaller – ignore prompts to reboot now – and performs its own powerful scan. This roots out potential leftovers in the form of files and Registry entries – you review the list, decide what to remove, then reboot if necessary.

To remove programs in batches, select each program you want to get rid of, then click 'Uninstall'. The Programs

list focuses on desktop programs only, so select 'Windows Apps' to get a list of apps you've installed through the Microsoft Store, enabling you to remove those, too. Select 'Toolbars & Plug-ins' to quickly review all the browser add-ons you have installed (all popular variants – IE, Chrome, Firefox, Opera and Edge – are supported), plus remove those you don't want, need or recognise. It's a quick and effective way to trim down your browser's resource usage.

CLEAN MORE SETTINGS

One of the best free cleanup tools is CCleaner (www.piriform.com). The app boasts a number of tools to help you clean out the junk and recover gigabytes of files. Its main cleaning component searches more than just basic Windows settings, including browser settings (a source of hundreds of megabytes of potential waste), as well as popular programs and apps. It's tempting to click 'Analyze', then clean out everything it recommends, but you'll end up losing potentially useful settings. The step-by-step guide reveals how to use it to free up space without deleting those files you didn't know you needed.

Outside of its primary cleaning element, CCleaner offers a number of other tools. Its Registry cleaner is potentially the most dangerous, so skip that. Instead, select Tools, where you'll find seven cleanup tools. The Uninstall section works in the same way as Windows' Apps & Features tool, but is outclassed by IObit Uninstaller.

Startup provides you with a more comprehensive list of programs and items that launch with Windows. This is split into three tabs. 'Windows' contains a list of programs, organised by location (Registry or startup folder). It's the same list as in Task Manager, with one crucial difference: you can permanently delete entries (with care), as opposed to just disabling them.

Switch to 'Scheduled Tasks' to review what tasks Windows and other programs have set up – you'll find items such as backup tasks, program update tasks, and so on here. Again, you can disable or delete items. Select 'Advanced' mode and various



Remove unwanted browser add-ons to boost security, privacy, and performance.

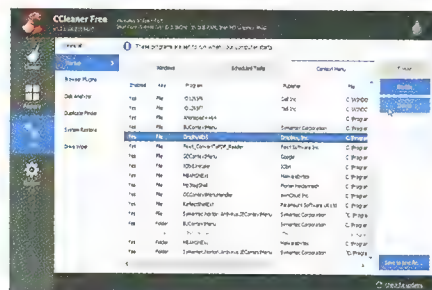
Windows-related tasks are shown. These should be left alone, so leave the box unselected after reviewing it.

One final tab – 'Context Menu' – is worth exploring. Frustrated at how programs clutter up the menus that appear when you right-click items in File Explorer? You'll find these items here, referencing 'Directory' (when you right-click a folder), 'Drive' and 'File' (when you right-click a specific file type – sadly, the actual file isn't listed). Disable or delete those you don't want – if they keep coming back, examine the program's settings to see if you can disable them from there, or use its intransigence as an excuse to remove the app completely.

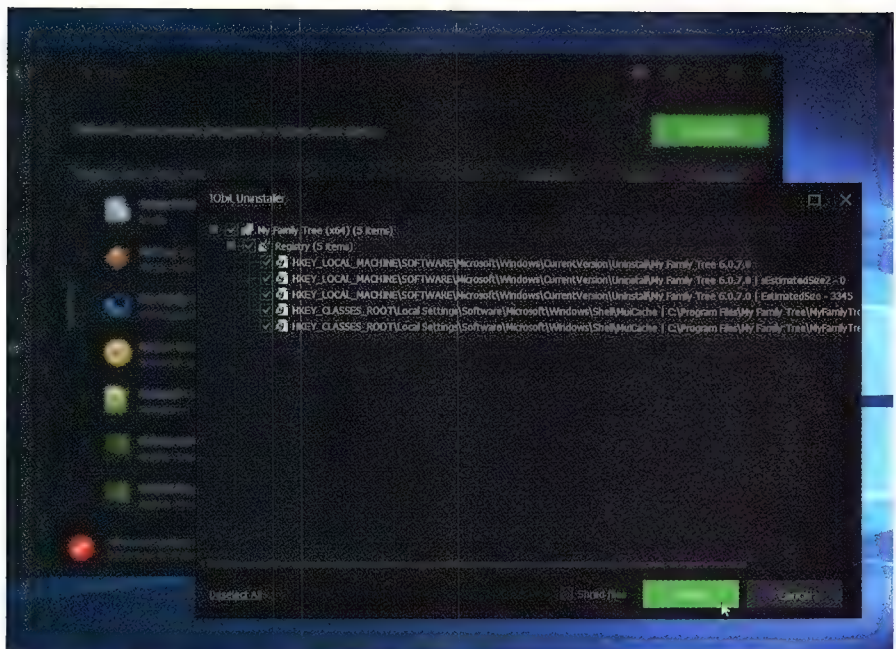
MORE TWEAKS

The 'Browser Plugins' tab works in a similar way to IObit Uninstaller's Toolbars & Plugins section. Skip the Disk Analyzer and Duplicate Finder tools for now – we'll look at these (and more powerful alternatives) later on.

System Restore lets you view all the Restore points on your PC. Each one is clearly labeled, and you can remove them individually or in groups (hold



Use CCleaner to strip back your context menus to make them more manageable.



IObit Uninstaller provides you with a powerful tool for removing extra leftover elements.

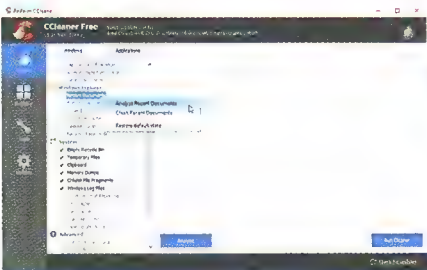
Ctrl as you click each one to select it) without affecting others. The most recent Restore point is always grayed out for safety reasons.

The final tool, Driver Wiper, makes it possible to wipe free space or an entire drive securely. Instead of marking deleted files as space available for writing over, making them vulnerable to data recovery tools, you can securely wipe the space by overwriting it.

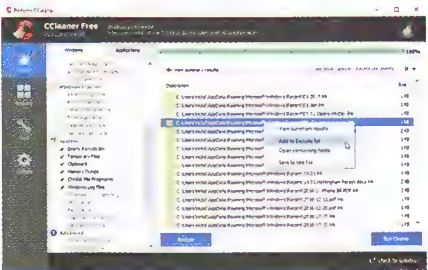
This is slow, and should only be done when you have sensitive data to wipe. You can also wipe free space and mark non-deleted files and folders for secure removal from CCleaner's main Cleaner component — scroll to the bottom of the 'Windows' tab, and select each box ('Custom Files and Folders' refers to any files or folders you specify under 'Options > Include'). If you'd like CCleaner to securely wipe all files from its Cleaner tool, go to 'Options > Settings' and select 'Secure file deletion (Slower)'.

Clean out your system with CCleaner

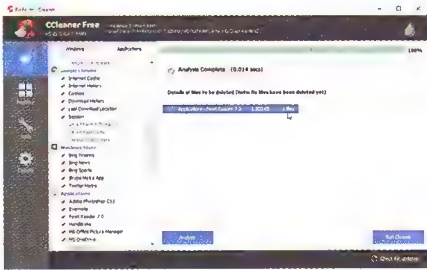
Dig a little deeper into your PC and apply the broom.



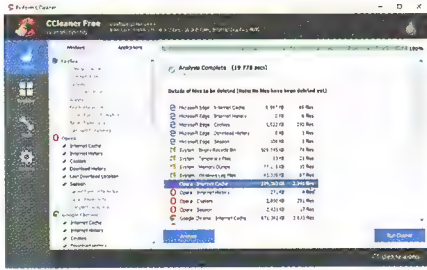
1 CHOOSE WHAT TO SCAN
CCleaner's Cleaner component comes with some settings pre-selected. It's a good idea to review these thoroughly, unselecting those you don't want to lose, and selecting the settings you'd like to clean. Unsure what files a particular setting might delete? Right-click it and choose 'Analyze...'



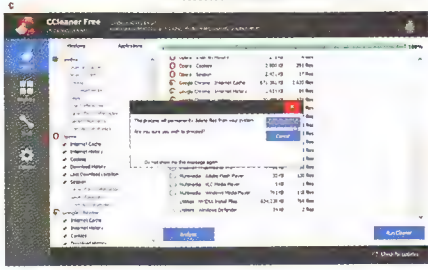
2 REVIEW ANALYSIS
CCleaner performs a limited scan on the chosen setting. To view exactly what it's found, double-click the summary in the right-hand pane (such as 'Microsoft Edge — Download History') and a list of all files is shown. Right-click files to exclude them from future scans or open the parent folder.



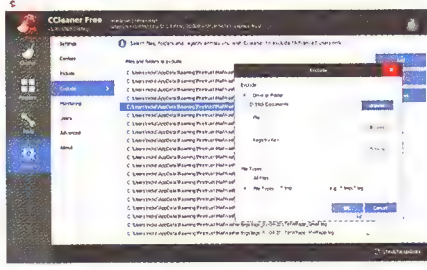
3 CONTINUE CHECKING
Scroll down to view all Windows settings — if in doubt, perform an analysis on the specific setting, or unselect it to exclude it from the full scan. When done, switch to the Applications tab to see which programs are supported. Scan these in the same way, unselecting those you wish to leave alone.



4 ANALYSE AND CLEAN
Click 'Analyze' and wait while CCleaner performs a complete scan. When it's complete, a summary is shown, listing all the components you've selected, complete with how much space you might save. As before, review individual components by double-clicking them.



5 CLEAN UP YOUR PC
Ready? Click 'Run Cleaner'. A warning dialog pops up — this is your last chance to back out (files are deleted, not sent to the Recycle Bin). If you're happy to proceed, click OK and watch as CCleaner clears up gigabytes of hard drive space to give you some much-needed breathing space.



6 MANAGE EXCLUSIONS
Click Options and select 'Exclude' to review what items are excluded from your scans. You can remove files you've placed here ('Ctrl-click' those files to select them, then click 'Remove'), or add files, folders, Registry keys (not relevant here), and file types to the list by clicking 'Add'.

Make your hard drive more manageable

Discover how to bring order to your chaotic hard drive.

Your PC is hopefully noticeably zippier, but there's still room for improvement. Before we tackle a really deep spring clean, let's divert our attention for a moment to hard drive management. Unless you're the most organised person in the world, it's likely your filing system is a little haphazard. And if you've got multiple hard drives, it's likely you have multiple copies of files, too.

First, consult the box below for general advice on what to look for when rooting out and removing duplicates — this could save you from potentially deleting the wrong file or files when you come to clean up.

FIND DUPLICATES QUICKLY

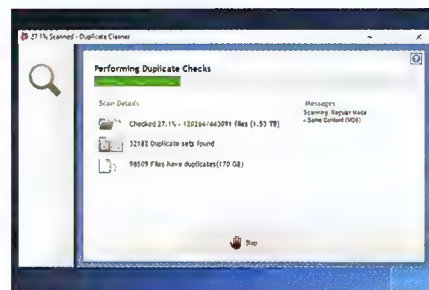
CCleaner comes with a built-in file duplicate finder, but it's not very sophisticated. It matches purely on file name, size and date last modified. We want something more thorough, so download the free version of Duplicate Cleaner (www.digitalvolcano.co.uk/duplicatecleaner.html), which has all the functionality you need.

First, choose what to search for — the default options search files by content rather than name, size or date. You can

also set filters — such as documents, pictures or music — or files to include or exclude, plus limit your search to files of a certain size and date. For a system-wide sweep, leave the defaults as they are and switch to the 'Scan Location' tab.

Next, elect where to search using the tools provided — whether it's entire drives or specific folders. If you want to exclude a specific location, add it in the usual way, then right-click it and choose 'Exclude Selected Path(s)'. When you're ready, click the 'Scan Now' button and wait while Duplicate Cleaner does its work — it's not a quick process, so be prepared to leave your PC on for several hours or even overnight, depending on the size of the folders you're scanning. If necessary, minimise the scan window while you work on other tasks.

You can review the results on the 'Duplicate Files' tab ('Duplicate Folders' is restricted to Pro users only) — they're listed in no particular order. Focus on the largest files by clicking the 'Size' column header twice. You can now go through the list, manually selecting the duplicates you wish to remove or you can use the 'Selection Assistant' buttons to speed things up. If you have a single folder or location



The scanning process can take some time—hours, in fact. Patience is a virtue.

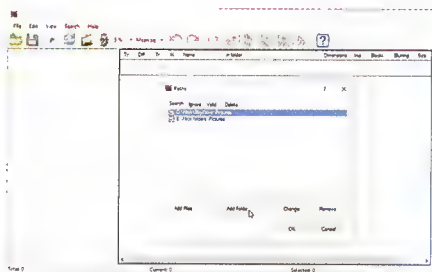
where your original files sit, you can specify that with 'Select by Location', which tells Duplicate Cleaner to target files in other folders for deletion. Once done, you can select all other files by clicking the magic wand button, and choosing 'Mark > Select by group' > All but one file in each group.

Duplicate Cleaner offers many matching tools to try to automate the selection process, but you may find it's easier, quicker, and safer to go through the list by hand, weeding out unwanted files, and periodically clicking 'File Removal'. From here, you can choose whether to delete the file completely, or send it to the Recycle Bin.

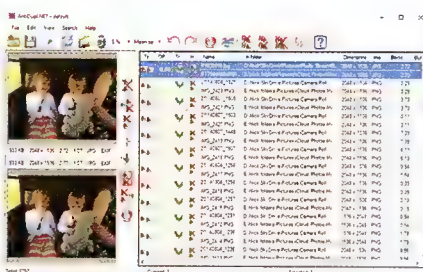
The program can be quite slow at times, and appear non-responsive.

Streamline your photo collection

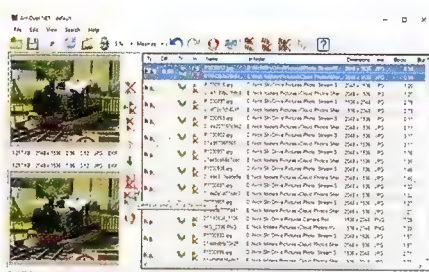
Get rid of duplicates simply and easily.



1 SET SEARCH PARAMETERS
Launch AntiDupl, select 'Search > Options' and select 'Search rotated and mirror image dupls' if you wish (click OK). Now select 'Search > Paths'. Click 'Add Folder' to add a folder or drive to search — repeat for as many locations as you need. Click OK.



2 REVIEW RESULTS
Click the play button and wait while folders are searched and compared (click 'Background Mode' to minimise to the System Tray). When the scan finishes, AntiDupl lists all found duplicates and similar files. See the main text for advice on what settings to choose for each find.



3 PERFORM CLEANUP
As you click a button for each result, it disappears from the list, and the next item comes into view. Work through the list — you can select multiple items at once using 'Ctrl-click'. If you close the program, you can relaunch it later, and the results are saved, ready for you to resume working.

What to look for when cleaning duplicates

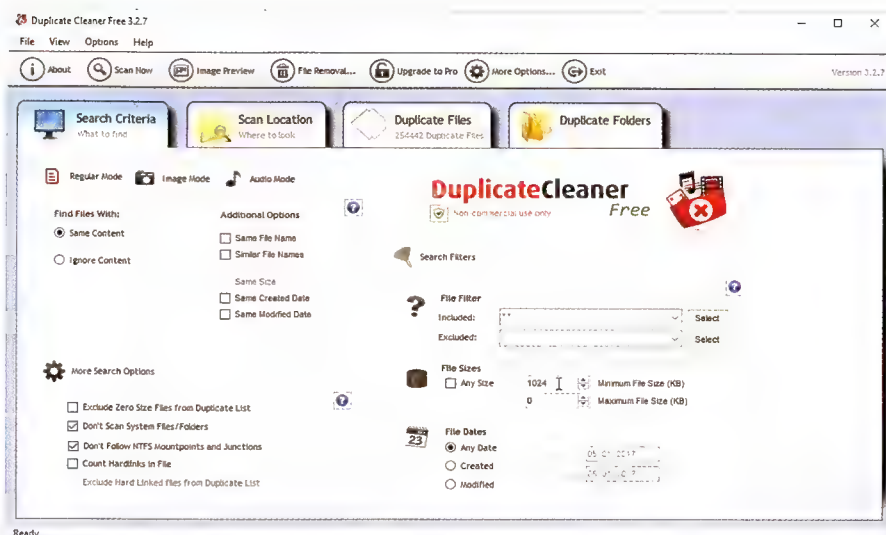
Backups of critical files are — of course — important, so any file cleaning needs to bear this in mind. Also you may have renamed a file without changing its content, so a good duplicate finder utility should not simply match files by their names (which could be disastrous if two completely separate files with the same name become linked together), but also by the file's properties, too, from its size to the date it was last modified — that's especially important with digital photos that have been downloaded from different cloud providers, each one naming them differently. And what about the legions of digital photos cluttering up space on your hard drive? It's not uncommon to take five or more shots to ensure you get one usable one, but what about the rest? You only want to keep the best copy, but manually trawling through all your photographs can be a daunting task. Panic not — we'll reveal a tool that makes this job that bit simpler.

The end result should be this: You have one master copy of your files, plus as many backups as you need. These could be stored as an exact backup copy in one backup folder (which you'll need to identify to make sure it's ignored by the duplicate file finder), or you might have them backed up using a tool such as Windows' own File History, in which case, the backup won't be touched by your file weeding. All other copies — or slight variations — then become candidates for removal.

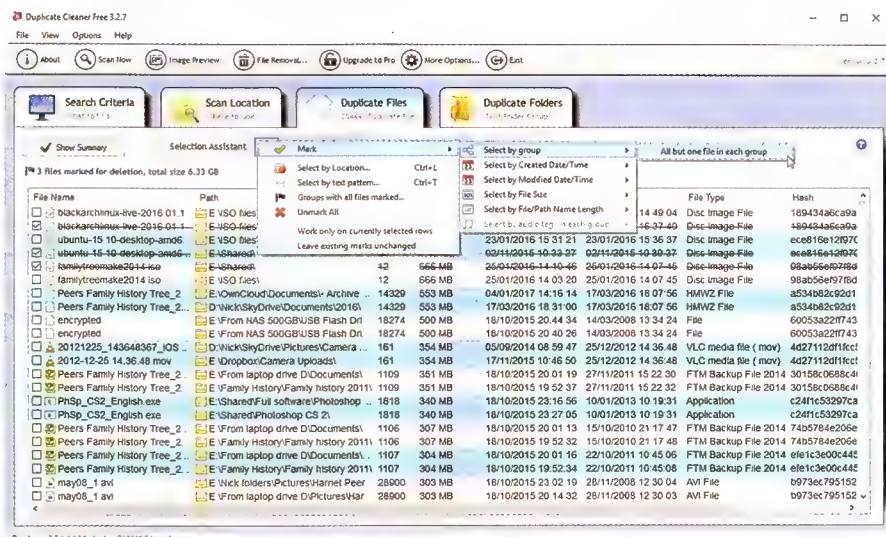
The trick is to be patient, and it soon comes back to life. If there's a long list of files to clean, you may want to take a break. Simply close the program — when you next launch Duplicate Cleaner, your results are ready and waiting for you to continue processing.

MANAGE YOUR PHOTOS

When it comes to managing your photos, you need a tool that can search for similar-looking images, as well as identical matches. You'll have to upgrade to the Pro version of Duplicate Cleaner for that functionality, so our favorite alternative is the free — and open-source — AntiDupl (antidupl.sourceforge.net/english/index.html). Download the latest version and



You can configure Duplicate Cleaner to refine its search for specific content only.



Speed up selection by having Duplicate Cleaner select all but one file in each lot of duplicates.

double-click the .exe file to extract the program folder. Open this, and double-click 'AntiDupl.NET.exe' to get started. The step-by-step guide reveals the basic procedure you need to follow, but as always, it pays to move slowly through each photo in the list, to be sure you've got the right match.

By default, AntiDupl assumes the first folder you added to it is the 'master' folder — the one where the files are (by default) left untouched. When the search results appear, you'll see a preview of each photo on the left, complete with basic information confirming the match. Next to each photo, you'll see three buttons: taking the first photo, the top-most button deletes both copies, while the second icon overwrites the second copy with the first. The next button removes the top photo.

Below the two arrow buttons, you'll see three similar buttons, with the first one highlighted in red, indicating that the second photo is set to be deleted by default. Below this is a button allowing the second copy to

overwrite the top one, and the final button — the hand signal — allows you to mark this match as a 'mistake', ensuring it's ignored in future.

Click a button, and the desired action is performed now, and the next item is selected, ready for you to act on. You'll see similar buttons appear under the menu bar — if you select multiple entries together using 'Ctrl-click', you can click these buttons to perform the same action on all the matches. There's also a 'Process selected results automatically' button for applying the default action to all of the results — not something we recommend, unless you're feeling very brave or working on a small set of results.

As you go down the list, you'll come to photos that aren't exact matches, allowing you to remove similar photos, too. All deleted photos are sent to the Recycle Bin by default, giving you a fail-safe in case you make a mistake, so be sure to empty the Bin once you're happy to free up the space.

Perform a heavy-duty PC cleaning

Still not satisfied with your cleaning efforts? Read on for a collection of more advanced cleaning tips

At last, we reach the final curtain. If your PC still isn't running as smoothly as you'd like, let us take more drastic steps to bring it under control in this last section on cleaning, diving deep to squeeze out every last possible optimisation we can find. We'll also reveal some final tips for optimising drive space, to ensure your hard drive doesn't fill up too quickly going forward.

First, you'll notice that we haven't included Registry cleaning as part of this feature. Registry cleaners would like you to think they can perform minor miracles when it comes to performance. They can't. Even if they weren't justifiably shunned for their ability to delete critical Registry entries along with genuinely redundant ones, the act of simply deleting Registry entries isn't enough in itself to speed things up. The fact is, Windows 10 is more than capable of managing and optimising the Registry, so leave it well alone.

DEFRAG YOUR DRIVE

These days, more and more people have SSD drives, which don't require defragging. Older platter-based (HDD) drives do, however, and it's likely that you have at least one of these installed, either internally or attached via USB. Windows' built-in defrag tool should be adequate for most people's needs, but if you want to push the boat out further, download and install the free version of Defraggler (www.piriform.com/defraggler).

Defraggler can differentiate between SSD and HDD drives, so it only defrags the latter. Go to 'Settings Options > Defrag tab' and you can optimise your drive by moving larger files to the end of the drive, which can help boost performance that bit more. It's also possible to analyse and defrag individual files via the 'File list' tab or by right-clicking the file in File Explorer — handy for a quick boost when working with specific large files.

MANAGE SERVICES

Startup programs aren't the only

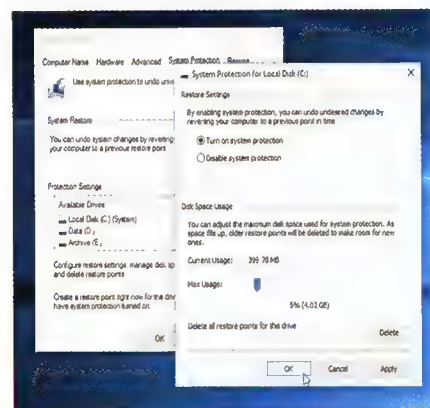
things launching with Windows, extending your boot time, and grabbing resources — system (and third-party) services do, too. You can manually review and optimise these via the Services management console (type "services" into the Search box), but for a quick and easy optimisation, download the free version of PC Services Optimizer (www.smartpcutilities.com/servicesoptimizer.html). Once installed, launch the app. After visiting Services Manager, waiting while the services list is populated, and clicking 'Backup', select 'Automatic Tuneup' and answer a series of questions split into four sections: 'Hardware', 'Security', 'Internet & Network' and 'System Functions'. Click OK and any unnecessary services are promptly disabled, providing you with a minor speed boost.

Gamers should also check out Gaming Mode. This enables you to temporarily disable services by switching Gaming Mode on to maximise performance for gaming or similar processor-intensive tasks, such as HD video editing. Click 'Preset' and experiment with 'Minimum', 'Normal' or 'Maximum' settings, or manually select which settings to apply. Don't be surprised if Windows changes appearance — when you switch off Gaming Mode, things should return to normal.

If things appear to go wrong after you've made your tweaks, simply click the 'Rescue Center' button, and select your backup to undo your changes.

VISUALISE DRIVE SPACE

Running out of drive space, but unsure what's gobbling it all up? CCleaner offers a Disk Analyzer under Tools that can provide you with a quick summary for individual or collected drives, split into various categories (such as pictures, documents, or everything). When the scan completes, a pie chart divides everything up, while the largest files are listed below, complete with a checkbox enabling you to select specific files to delete via the right-click menu.



Tweak System Restore so it doesn't take up too much space on your hard drive.

Switch to portable apps

Why let programs take more resources than they need? Instead of installing a program on your PC — letting it scatter itself all over your hard drive and take up valuable space in the Registry — look to see if a portable alternative is available. Portable apps are programs that restrict themselves to a single folder; everything they need to run can be found inside that folder, so not only do you keep them in check (delete the folder, remove the program — completely), you also get to choose where they reside.

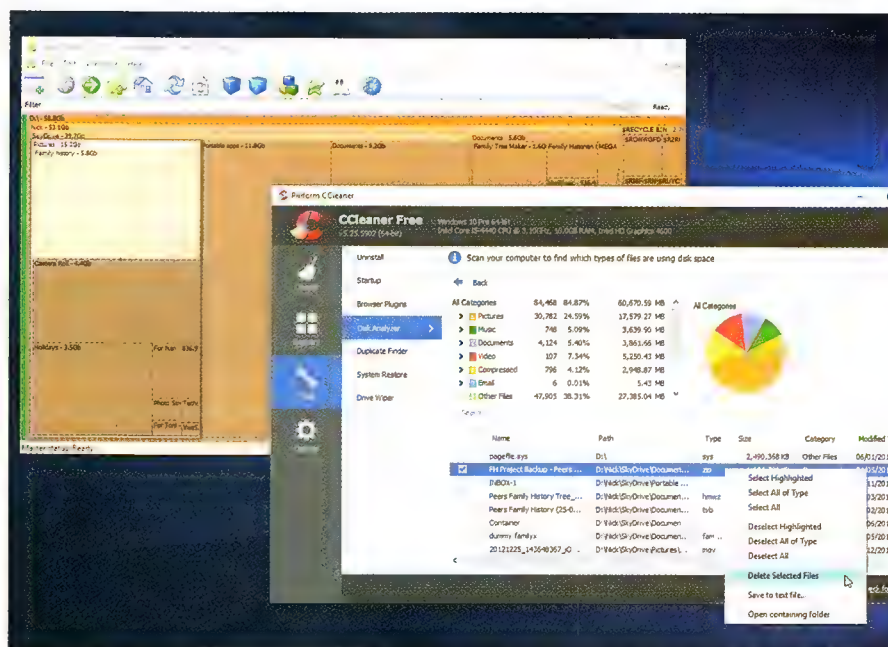
Portable apps are a particularly good choice when you have Windows installed on a small system drive — such as a 64GB or even 32GB SSD. You can store the apps on another drive, and leave enough space for Windows to run smoothly. Not only that, but if you have to reinstall Windows from scratch, the portable apps (and your settings) survive intact. You can even store portable apps on a USB thumb drive, enabling you to port them — and your preferences — to another computer.

A great place to start when building a portable app collection is www.portableapps.com. Install the PortableApps Platform tool, which provides a custom Start menu for easy access to your portable apps, plus makes it easy to install and update apps from its own extensive collection. You can add other portable apps — including those portable tools we've covered in this feature — by extracting them into folders inside the main PortableApps folder, and choosing 'Apps > Refresh App Icons'.

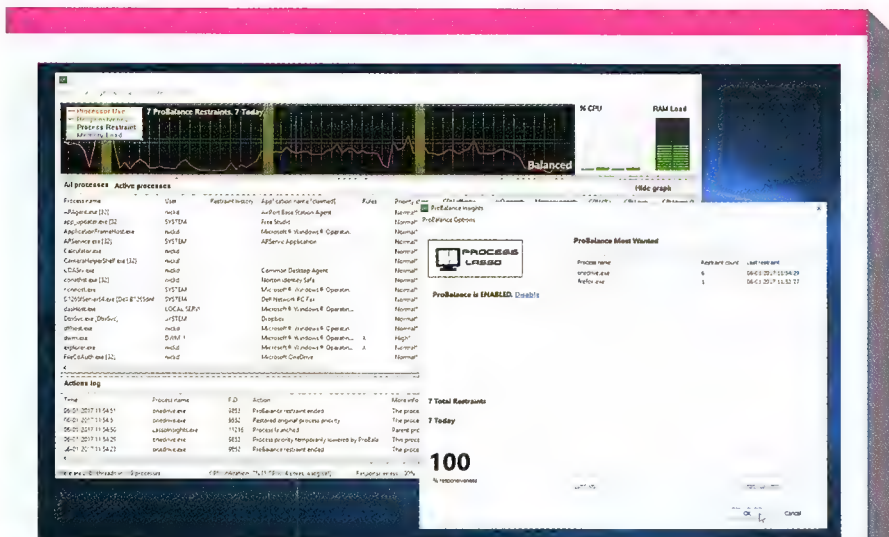
An alternative tool to try is SpaceSniffer (www.uderzo.it/main_products/space_sniffer). This portable tool (be sure to right-click it, and choose 'Run as administrator' to access all files on the selected drive) provides a visual view based on folder, rather than type, giving you insights into where all the space has gone, rather than what type of content is gobbling it up. Click a folder to peer inside it or double-click to go inside, and drill down deeper until you locate what's taking all your space.

MORE CLEANING TIPS

Type "restore point" into the Search box, and click 'Create a restore point'. Verify System Restore is switched on – if not, select your system drive, and click 'Configure' to do so. When you come to allocate space, consider limiting it to 5GB or 5%, whichever is smallest. This provides a good balance between giving you usable Restore



CCleaner and SpaceSniffer enable you to visualise your hard drive usage in different ways.



Rein in unruly programs

The act of running multiple programs (never mind numerous background processes) is a delicate one, requiring a fine balance to keep everything running smoothly. It doesn't always work, which is why your PC may sometimes seemingly grind to a halt or act sluggishly for a few minutes.

If you're running Windows 10 on an older PC or low-powered tablet or laptop device, you may find it frequently sticks, due to the competing demands of different processes. One solution is to scale back what you do — keep open programs to a minimum, and trim startup back, too.

If this doesn't help, then downloading and installing the Free version of Process Lasso (bitsum.com/processlasso) will, and it can even help on more powerful setups as well. When prompted, leave the default options as they are, and the main window opens to show you what's running on your device, and how Process Lasso is balancing it. Its ProBalance tool is up and running from the start, ensuring no process can overwhelm the system with its demands. A summary tells you how it's working, and the log reveals which processes have been neutered when their demands get too high (click 'Insights' for a handy summary).

You can also tweak things further: Open the Main menu and choose 'SmartTrim' to free up physical RAM when it's safe to do so. Select 'IdleSaver' if you'd like to cut energy usage, and choose 'Gaming mode' for those times when you want to play games or perform other CPU-intensive tasks, such as ripping or encoding HD video.

points and not swallowing up too much drive space.

One obvious way to free up space without deleting any files is to compress them. The obvious solution would be to right-click the file (or folder) and choose 'Send to > Compressed (zip) folder', but while you can easily browse their contents in File Explorer, third-party apps can't access the content unless you unzip it. An alternative is to use NTFS Compression instead, which compresses a selected folder while retaining its content. The folder is a little slower to process, but is more convenient to use. To do this, right-click the folder, and choose 'Properties'. Click 'Advanced' under 'General' and select 'Compress contents to save disk space'. Remember, it only works on NTFS-formatted hard drives.

One handy time-saving function is Jump Lists, which appear when you click 'v' next to an application in the Start menu, or right-click its taskbar entry. It pays to take the time to manage these thoroughly — click the pin icon next to an entry to pin it permanently to the top of the list, or right-click a redundant entry and choose 'Remove from this list' to get rid of it. You can quickly clear all Jump List entries using CCleaner (look in the 'Windows Explorer' section of the cleaner).

Finally, if you want to take full control of the startup procedure, download and run Autoruns (bit.ly/autoruns). Switch to the 'Logon' tab and you'll find significantly more startup entries than those provided by Task Manager or CCleaner. Unselect an entry to disable it, or right-click it for more options, including deleting it and checking it for possible malware. ■

howto

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

WINDOWS

ANNIVERSARY UPDATE INSTALL ERROR

My Sony VAIO won't update to the Anniversary Update (v1607). It consistently fails, and shows the following error code: 0x800705b4. Its constant attempts to download and update are really eating into my monthly allowance. Do you have any ideas that will help with this very frustrating problem?
Steve Dale

There are a number of fixes you can attempt for this one. First, type "troubleshoot" into the Search box to access the 'Troubleshooting Control Panel'. Click 'Fix problems with Windows Update', then click 'Advanced' followed by 'Run as administrator' before clicking 'Next'.

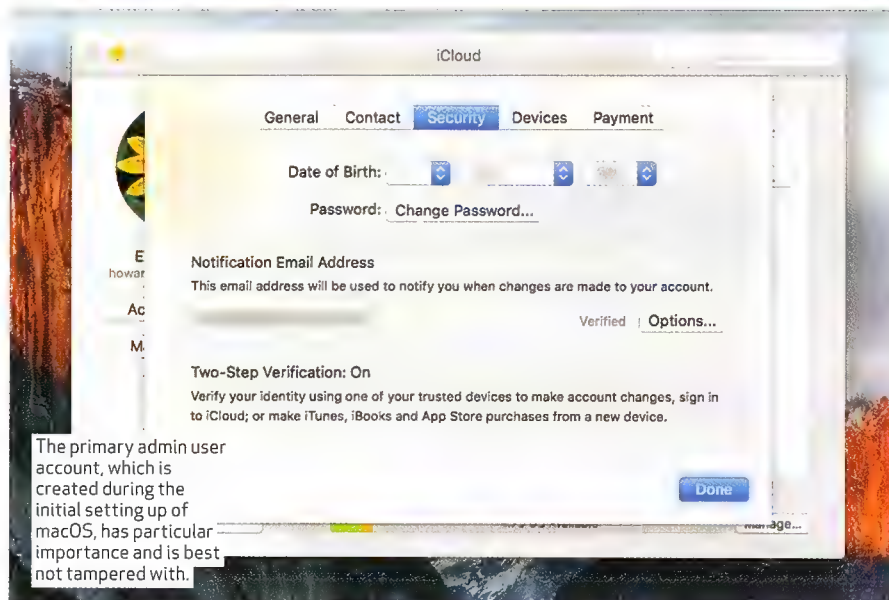
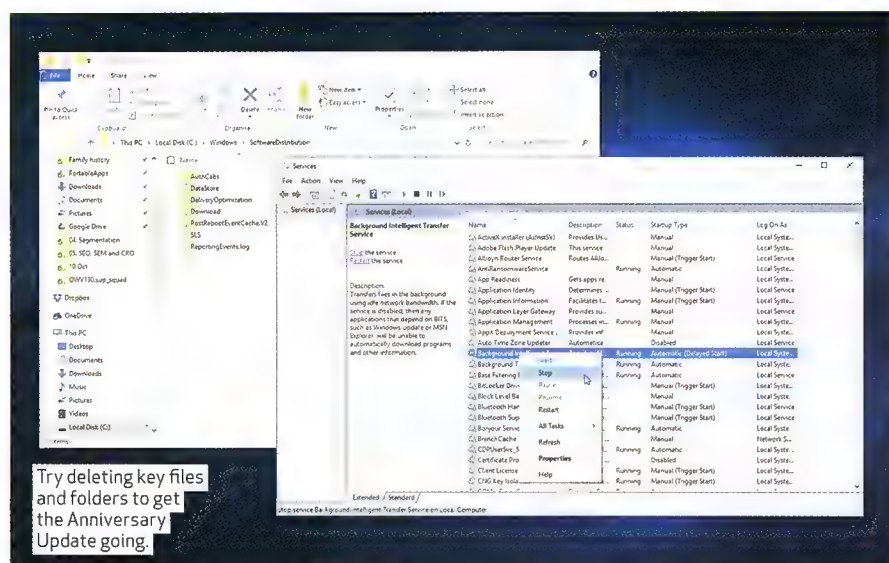
If this doesn't work, reboot, then press 'Windows-R', type "services.msc" and click OK to open the Services console. Right-click 'Background Intelligent Transfer Service' and choose 'Stop'. Now open File Explorer and navigate to C:\Windows\SoftwareDistribution. Select everything in here — folders and files — and delete it. Not all files will delete, but it's crucial both Download and Delivery Optimization folders are removed (if they refuse to do so, reboot, stop the BITS service once more and try again). Once deleted, reboot and see if Windows Update now works correctly. If not, try downloading the standalone installer (go to 'Settings > Update & Security > Learn more', then click the 'Get the Anniversary Update' link), or download the latest version of the Media Creation Tool and 'upgrade' Windows to the latest version.

Alex Cox

MAC

MAC ADMIN ACCOUNT SHENANIGANS

When I bought my iMac a couple of years ago, I used Migration Assistant to set it up from my old MacBook. But that laptop used my wife's account as its primary user, and that was transferred across to the iMac. Each time I start up my iMac, it opens in my wife's name, and I have to

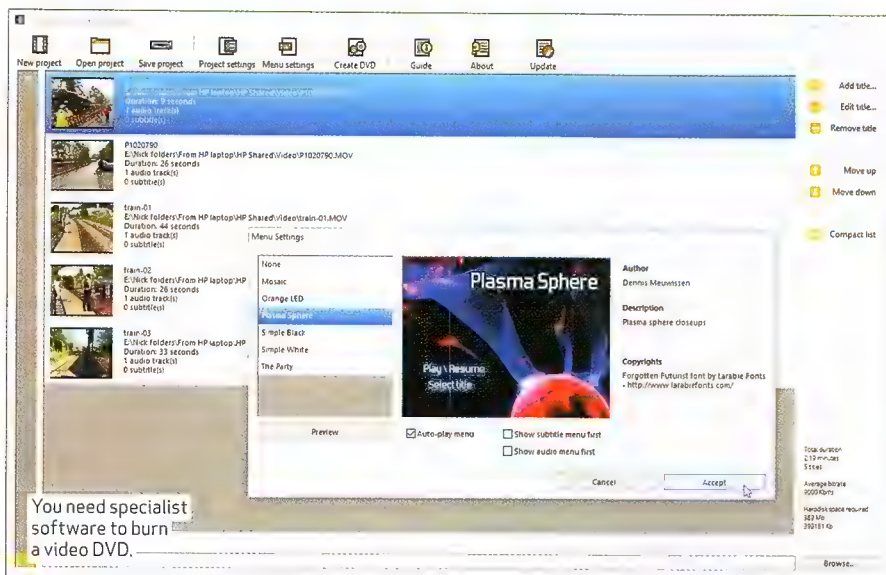


log out and back in to access my account. How can I adjust the iMac so that mine is the main account, and my wife's account is removed?

Colin Heaton

The first admin user account that's created is special in macOS, so although it's possible to fudge things in the Users & Groups pane and in Terminal, it's far better to make the

necessary changes by setting up from a clean installation of macOS. Ensure that your iMac is fully backed up, preferably keeping an extra copy of important documents, including your keychain. Keep the backup ready with a high-speed connection to your iMac, then restart in macOS Recovery (hold 'Command-R' at startup) and use Disk Utility to erase the startup disk, then install macOS on it, making yourself



the sole and admin user. During setup, use Migration Assistant to transfer just your documents and settings from the backup.
Howard Oakley

MULTIMEDIA

HOW TO BURN A VIDEO DVD

I'm trying to create a video that will play on a standard DVD player. I've edited it using Windows Movie Maker, but the resulting discs that I burn won't play on anything. Can you help me overcome this seemingly insurmountable hurdle?
Terry Mitchell

Terry was running Windows 10, which meant the files he was creating in Movie Maker can't be directly burned to DVD. Instead, he was saving the files, then burning them to disc — this method results in a data disc, not a bona-fide video DVD. He'll need additional third-party software, and the good news is there are options. We prefer DVD Flick (www.dvdflick.net) as it's clean and open source. Make sure you export your video from Movie Maker using the recommended option, then import this file into DVD Flick via the 'Add Title' button and use its menus and tools to build your disc. Before burning, be sure to click 'Project Settings' and select your DVD drive from the 'Burning' section.
Cat Ellis

WINDOWS

MICROSOFT ACCOUNT: PASSWORD GLITCH

I changed my Microsoft Account password and now I keep getting this Windows error message: "You need to fix your Microsoft Account for apps on your other devices to be able to launch apps and continue experiences on this device." Help!
John Wallis

This is linked to the password change affecting an app or service previously linked to that account. Ordinarily, it can be fixed by going to the Windows Store app and signing in, but John kept getting an error code — 0x8013153B — whenever he tried to open it. We pointed him to three options: type "Find and fix" into the Search bar to access the 'Find and Fix Problems Control Panel' (click 'View all'), then run Windows Store Apps, Background Intelligent Transfer Service, and Windows Update in turn. All three reported problems and attempted fixes, but to no avail.

Next, we went to the Microsoft Store reset options in Tweaking.com's Windows Repair tool (www.tweaking.com), but also to no avail. But, after running Windows Repair, the Store gave a different error, which John investigated. This led him to running `inetcpl.cpl` from the 'Start > Run' box, then clicking 'LAN settings' under the 'Connections' tab, which revealed the proxy

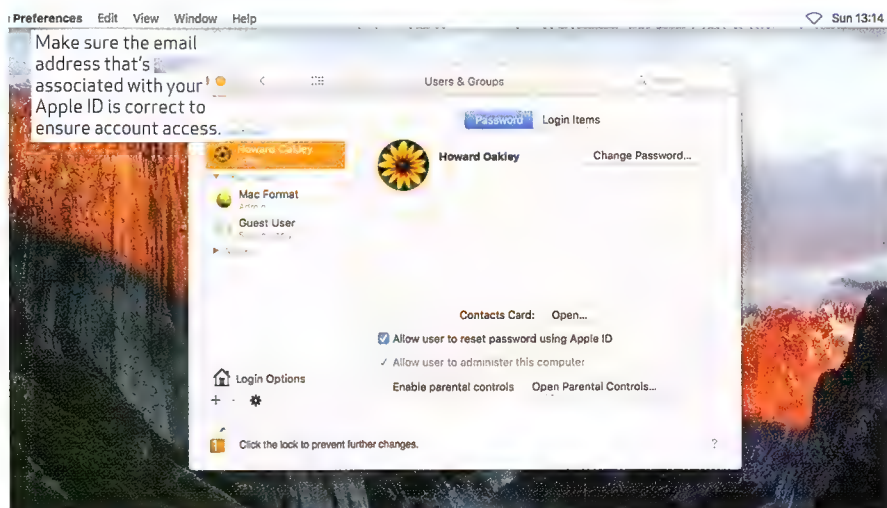
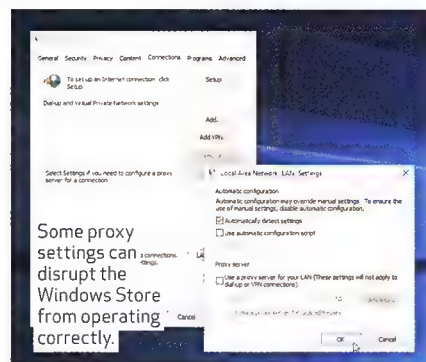
server box had been ticked — unticking this and clicking 'OK' twice resolved both the Store and account problems.
Nick Peers

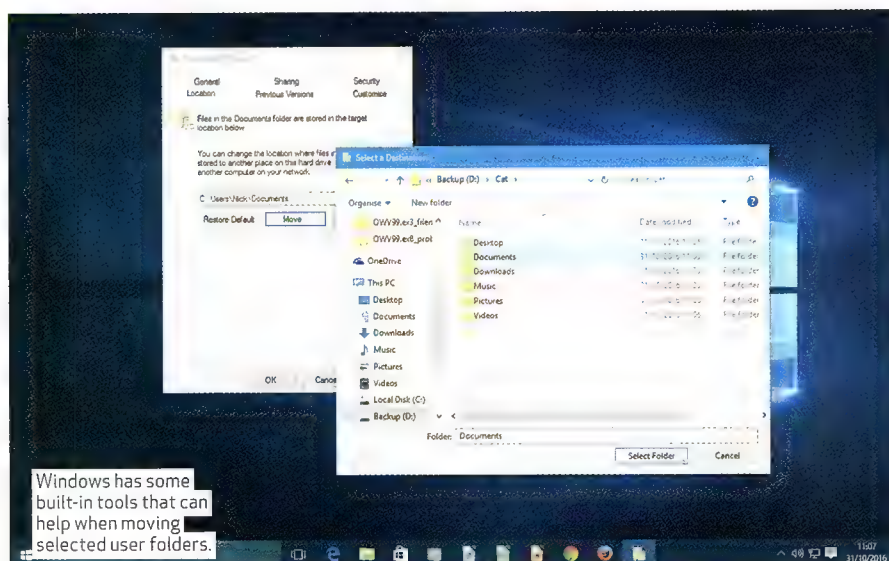
SECURITY

APPLE ID WOES

A friend forgot the password for her Apple ID. She used to live in France, and when she initiated Apple's Forgot Password procedure, instructions were sent to her old French email address. She can still access that, but not for much longer, so she now uses a Gmail address instead. Can she change her Apple ID's registered email address so that, should she need a password reset in the future, she'll still be able to receive the message?
Malcolm Weatherhead

She can change her registered email address, and she must do so as a matter of urgency, before her French one shuts down. Apple provides detailed instructions for changing an Apple ID's email address at bit.ly/AppleIDaddy. Many Apple ID accounts are associated with an .icloud.com (or .me.com or .mac.com) address, which is readily accessed using Apple's Mail or another email app. This is the simplest way of maintaining your Apple ID, but you may not want another email account to manage, so you can use an existing address,





such as one from Gmail, as your Apple ID. Ensure you're able to read any messages that Apple may send to that address.

Although it's a tad more complex, it's much safer to have at least two addresses: one used solely for Apple ID messages and associated with that ID, and one for general messages. This helps you tell real messages from phishing attacks, as any genuine messages from Apple about your account will go to that private address. You should enable two-step verification (or two-factor authentication, bit.ly/appletfa) to make it harder for someone to break into your account.

Howard Oakley

SECURITY

SECURE DIGITAL DOCUMENT STORAGE

I'm sure this will resonate with other readers who are trying to switch from paper to digital — what's the best way to back up this data and keep it secure?

Colin Sexton

The simplest solution is to use cloud storage such as Dropbox, Google Drive or OneDrive, but you may want to take an additional step for particularly sensitive documents — if you use VeraCrypt (veracrypt.codeplex.com), for example, create an encrypted container file inside your cloud storage to store private files inside, providing an extra layer of security.

If you own a network drive that's billed as a 'personal cloud', you could eschew all third-party services and use that instead — either with its own proprietary software (such as Western Digital's MyCloud) or using the open-source ownCloud (owncloud.org) solution instead. Again, employ it in conjunction with

VeraCrypt or similar service to ensure your data is doubly encrypted.

Nick Peers

WINDOWS

MOVE USER FOLDERS TO NEW PARTITION

My Windows 10 PC has a large data partition I'd like to store documents and other personal files on. How can I point Windows to this partition?

Donald Lincoln

We've put together a short step-by-step guide that reveals how to move your data and let Windows know where it's now residing. It'll also show you what to do after a reinstallation in order to regain access to those folders using your newly recreated user account.

1. Create a named folder (such as 'Donald') on your data partition, then create folders inside this for Documents, Pictures, Videos and any other system folders — including desktop and downloads — that you want to move.

2. Open File Explorer and click 'This PC' to reveal six of your user folders (or browse to C:\Users\<Username> to reveal more such as Searches or Favourites). Start by right-clicking the Documents folder and choosing 'Properties'.

3. Switch to the 'Location' tab and click the 'Move...' button. Navigate to the named folder you created in Step 1, then select the Documents folder and click 'Select Folder' followed by 'Apply' and 'Yes'. Repeat for each folder you wish to move.

4. If you later reinstall Windows using the same user account, simply repeat Steps 2 and 3 to pair the folders with Windows again; if not, you may get a prompt about access being denied — if so, click 'Continue' to regain access.

Cat Ellis DRIVERS

MONITOR SCREEN STRETCHED

I updated to the Windows 10 Anniversary Edition and now my monitor screen is stretched. Both Device Manager and IOBit Driver Booster claim my drivers are up to date. What's happened?

Scott Spiers

First, we confirmed Scott's problem was down to an incorrect resolution setting, which he confirmed it was (the screen was 'stuck' at 1,024 x 768 pixels). We next asked for Scott's PC model, which revealed his Dell PC was powered by an AMD Radeon HD4300/4500 card. Sadly, this generation of cards isn't supported in Windows 10 — AMD seemingly drops support for older graphics cards much quicker than its rivals Nvidia and Intel. Nevertheless, Scott didn't have this problem prior to the Anniversary Update, and a quick check online revealed that other Radeon HD4000-series owners had successfully got their cards working in Windows 10 by downloading the last supported version of the driver — 13.1. Although rated for Windows 8, it should work in Windows 10 too. Get this from bit.ly/ati-legacy — download the Software Suite version, then double-click the setup file and follow the prompts to install the drivers.

Graham Barlow

EMAIL

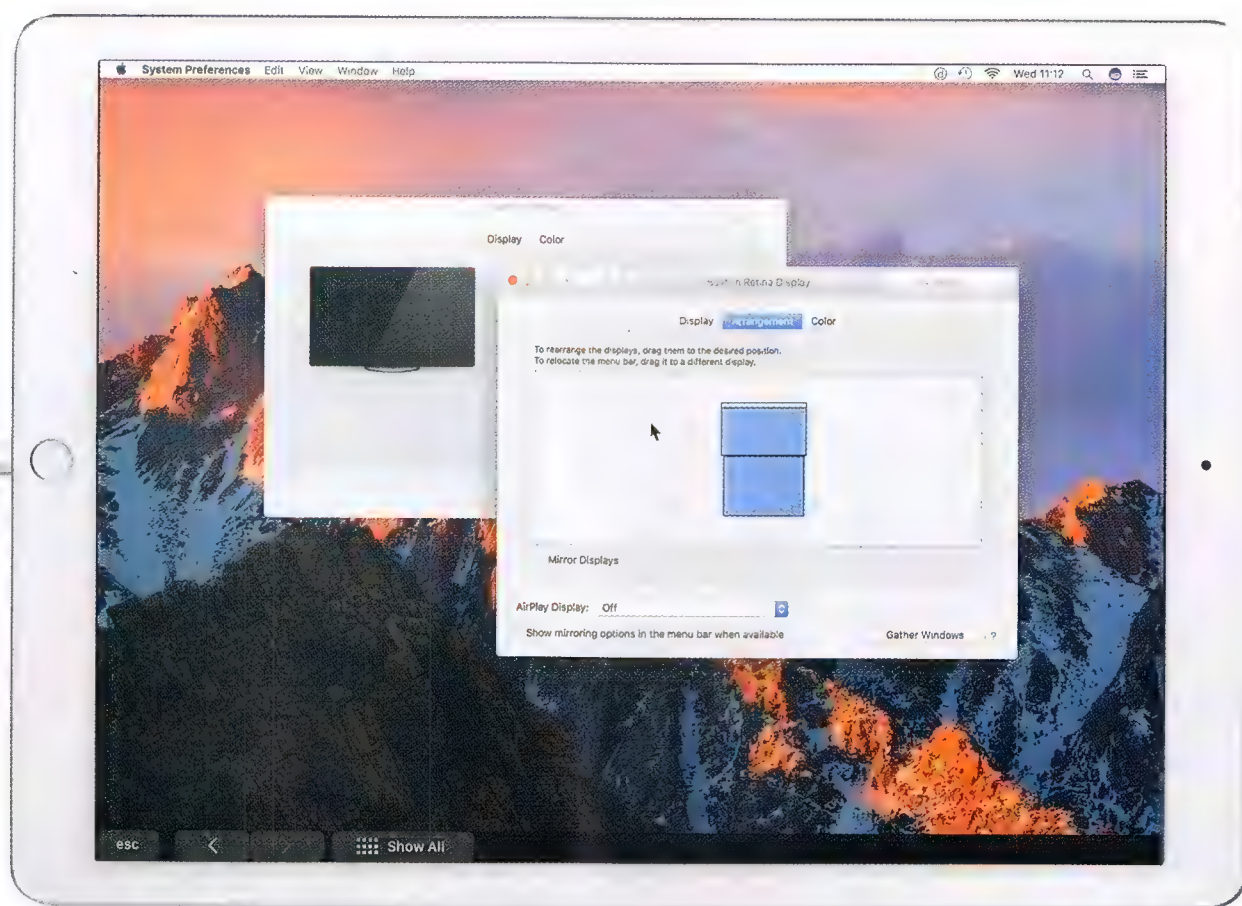
DITCH YOUR UNWANTED EMAILS

For the past month or so, I've been swamped with unsolicited email (I use Windows Mail as my email client), and the usual method of unsubscribing hasn't worked. I've moved them to my junk folder but they're still obtrusive. Can you help stop them?

Bryan Little

Sadly, there's no way of blocking this kind of spam — once your email address has fallen into the hands of spammers, which is all too easy nowadays (however careful you might be), then it's a case of dealing with the unwanted mail rather than trying to find ways of avoiding it. Going forward, though, never click any links in unwanted email as you merely confirm your address to the spammer at the other end. The best way to process such mail is with a mail-filtering tool like Mailwasher (www.mailwasher.net) which, over time, learns to automatically blacklist messages and prevent them from ever reaching your email program.

Matt Hanson ■



Turn your iPad into a Touch Bar for your Mac

Discover benefits of Apple's input innovation and turn your iPad into a Touch Bar with Alan Stonebridge.

Apple's Touch Bar technology puts context-sensitive controls at the top of the keyboard in the hope of saving you time digging around in menus and windows to find the commands you need. Currently, the only official way to get a Touch Bar is to buy a MacBook Pro, and even if Apple were to update its Bluetooth-connected Magic Keyboard to include one, it's unlikely to be affordable given the existing model costs \$165.

However, you can add a Touch Bar to your existing Mac by adding an iPad and third-party software into the mix. If you don't have an iPad, there's a Mac app that enables you to see what the Mac's latest control method would add to your apps if you were to upgrade.

Be aware, though, that there's one aspect of the real thing that you can't replicate using the following methods: a Touch ID sensor for unlocking your Mac, validating payments online, waking your Mac, and more. (A real Touch Bar has a combined Touch ID sensor and power button at its right end.) That said, there are other ways to imitate some of the sensor's benefits; MacID (\$5.99, macid.co) enables you to unlock your Mac using the Touch ID sensor on your iPhone or iPad.

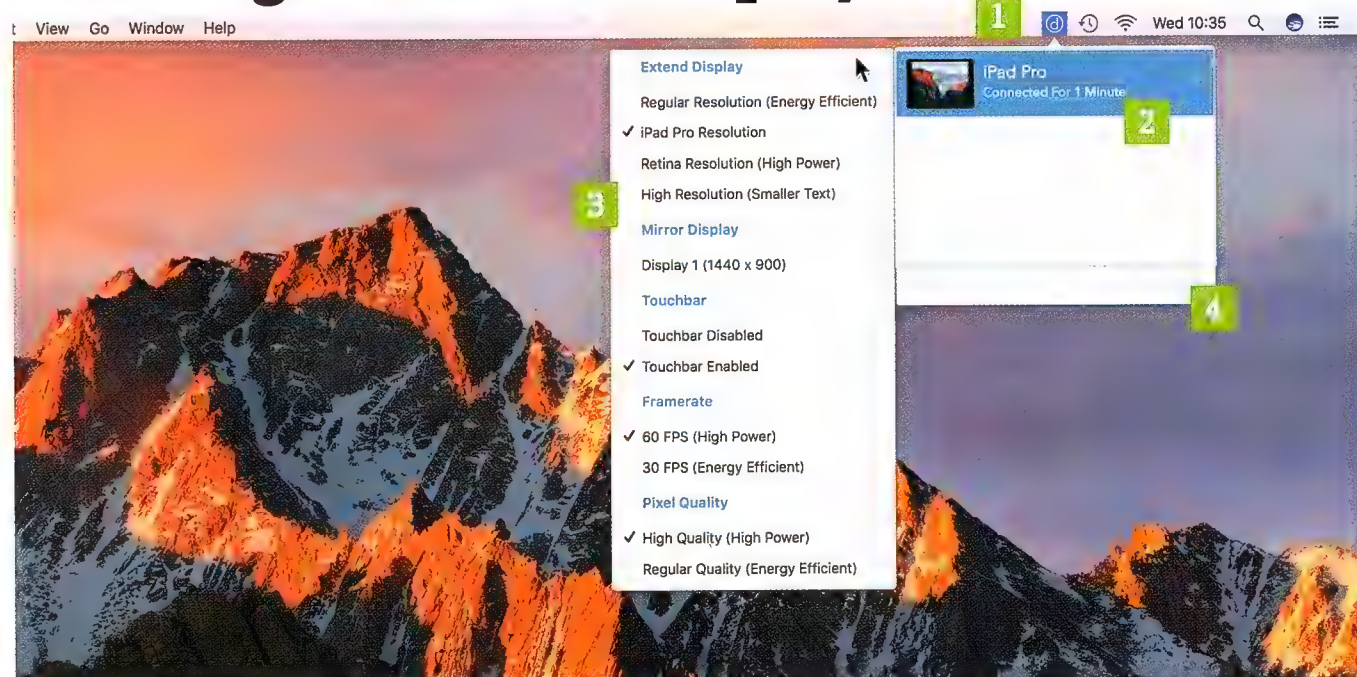
However, the bigger bonus of having a Touch Bar to hand is the range of time-saving shortcuts it provides in apps bundled with macOS, as well as a growing number of third-party ones, which includes OmniGraffle 7, 1Password and Mail Designer Pro 3.

If you have a Mac with a built-in Touch Bar, don't assume these pages are irrelevant to you; whether you're using the real deal or an iPad as a stand-in, you'll find tips later on in this tutorial on how to tailor the bar's contents and ensure you're getting the most from it.

TRY IT OUT FOR FREE

Any Mac that's running macOS Sierra 10.12.2 or higher is silently generating the content that would be displayed on a Touch Bar if one were present, it just doesn't have anywhere to show it. Also, macOS knows how that content should behave if you had a way to interact with it – which you can, thanks to a couple of third-party tools that use that internal model to mimic

Working with Duet Display



1 DUET DISPLAY'S MENU BAR ICON

This icon tells you Duet is running. It'll be dimmed if the app can't find your iPad.

2 CONFIRM THE CONNECTION

With your iPad connected over USB, Duet's icon goes darker and its menu shows the iPad's name.

3 VIDEO QUALITY SETTINGS

Put the pointer over your iPad's name to access settings such as resolution and frame rate.

4 DUET DISPLAY'S PREFERENCES

Click this cog to access Duet's preferences, including which GPU is used (if you have two).

a real Touch Bar on other Macs. The quickest way to see what a Touch Bar would offer you is Touché, a free utility from Red Sweater Software that renders macOS's internal model of the bar in a window. The app isn't simply a dumb display of that content, though; where you would tap or swipe controls on a real Touch Bar, you can click or drag them on Touché's window to get the same effects. This doesn't give you a true feel for the real thing, of course, but it's a good way to investigate the shortcuts your favourite apps would provide, given the right hardware.

Get Touché from red-sweater.com/touche, unpack the archive, move the app to the Applications folder, then open it. You can place Touché's window where you want – near the bottom of the primary display is probably best.

When Touché is running, macOS will reveal customisation options for the Touch Bar in System Preferences and compatible apps, which we'll discuss later.

THE BETTER (BUT PAID) OPTION

For an experience closer to a real Touch Bar, you'll need an iPad and its USB cable, and Duet Display (\$14.99, \$30.99 pro version, duetdisplay.com). This app also has the ability to extend a Mac's desktop onto an iOS device – in fact, this is its primary purpose.

Duet 1.6.3.4 for Mac and 1.3.7 for iOS enable the app to render the Touch Bar at the bottom of your iPad's screen, covering up a little strip across the bottom of the extended desktop. With your iPad propped up behind your keyboard – ideally a low-profile one, such as the Magic Keyboard – you end up with a rough but usable approximation of a real Touch Bar. Depending on the arrangement of your desk – say, if your primary display is raised high enough that your iPad doesn't obscure your view of it – this has the added advantage of giving you more space on which to stash apps you glance at only occasionally.

CUSTOMISE YOUR TOUCH BAR

By default, the Touch Bar displays contextual app controls on its left side and across most of its width, and a shortened Control Strip of system-wide controls towards its right end. Tapping the arrow at the left of the Control Strip expands it temporarily, filling the bar with additional items that appear in the top row of a regular Mac keyboard; you won't need these with Touché or Duet Display because you already have real keys for this function, but you can change the Control Strip's contents to include other shortcuts that usually require multi-key combinations, which you may have trouble remembering;

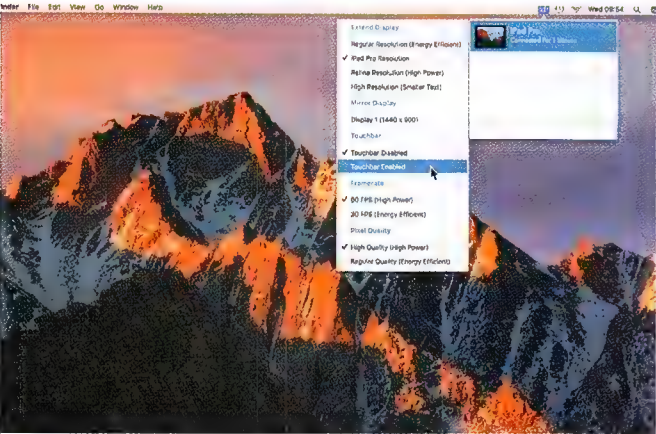
we particularly like the single-key shortcuts for locking the screen, putting our Mac to sleep and taking a screenshot. The latter of these even offers the ability to open screenshots in Preview immediately, or to file them in the Documents folder instead of on the Desktop.

In the walkthrough below, you'll learn how to customise what your Touch Bar displays by default and when you hold down Function, and how to alter the Control Strip's contents. Some apps that support the Touch Bar enable you to pick which of their controls are pinned to it. So in Safari, you can add controls to add a bookmark, open the Share menu so you can use the arrow keys rather than having to reach for your mouse or trackpad, or view the current page in Reader mode. Look for a 'Customize Touch Bar' item in an app's View menu. While customising the bar, note the 'Show typing suggestions' checkbox; clear it if you don't want predictive text suggestions, like those on an iPhone, to appear in the bar.

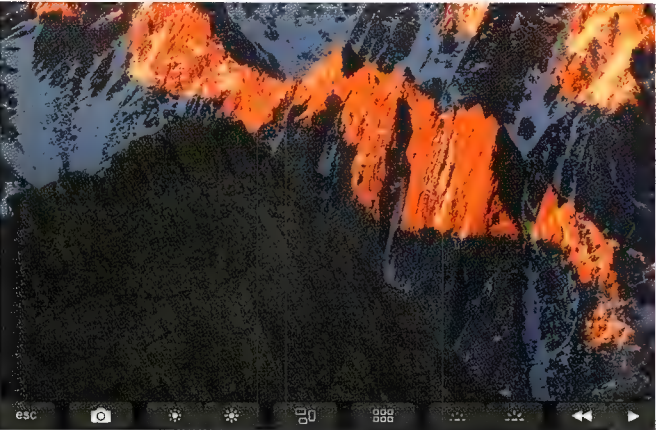
There's one thing to beware of when using Duet Display: on a Mac that had a secondary display already, we found Duet's Touch Bar was sometimes blank. Disconnecting the existing secondary display resolved this, so you should find Duet works fine if your Mac currently has only one display.

How to

Customise the Touch Bar's contents



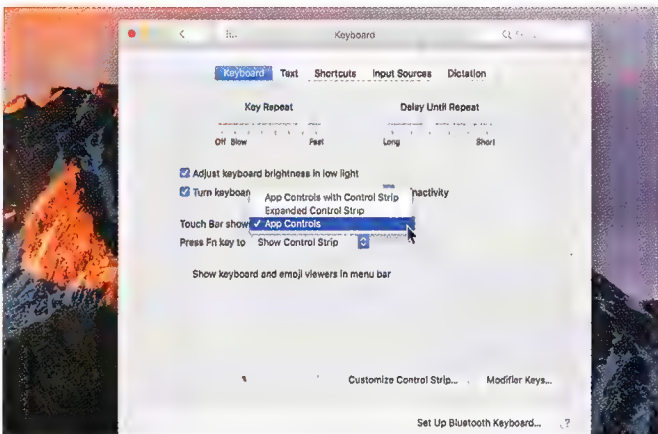
1 GET STARTED WITH DUET Install Duet Display on your Mac and iPad and open both versions. It should detect your iPad automatically. To show the Touch Bar on your iPad, click Duet's menu bar icon, put the pointer over your iPad's name and click 'Touchbar Enabled'.



3 SET ALTERNATE CONTENTS Holding Function usually shows numbered function keys in the Touch Bar. If you've no use for these, use the 'Press Fn key to' pop-up to set this to show the expanded Control Strip or App Controls; what's offered depends on your choice in Step 1.



5 ALTER ITS EXPANDED FORM Drag a control from the selection shown on the main display and move it over the bottom edge so it appears with a blue highlight on the Touch Bar, then drag left or right till it's in the position where you want it, then let go.



2 SET WHAT THE BAR SHOWS Go to the System Preferences Keyboard pane and stay on its Keyboard tab. Click the 'Touch Bar shows' pop-up menu: the bar can show contextual app controls and a compact Control Strip, only app controls, or the expanded Control Strip



4 CUSTOMISE CONTROL STRIP At the bottom right of the Keyboard tab, click 'Customize Control Strip' to see items you can add, including some that aren't used by default; those shown differ based on whether the strip is currently in its compact or expanded form.



6 REARRANGE ITEMS To rearrange Touch Bar items, move the pointer over the bottom edge of the main display (this time without dragging anything). One bar item (or group) is highlighted: move left or right to choose the one to move, then drag it left or right.

Block nuisance calls on your iPhone

Make sure fraudsters, phishers and telemarketers can't talk to you with a little help from Adam Smith.

These days, it's easier than ever to stay in touch with people all over the world, but it has a downside in that it's also easy for unsolicited calls to reach you. One cause of this can be that you've given your personal data to social networks, apps or services, perhaps because they require it as part of setting up an account.

Even if you trust that they won't share your details, a security breach could leak data and lead to fraudsters, phishers and identity thieves calling you to try to do you harm – not to mention the barrage of telemarketers or phoney PPI organisations that, should your number get onto one of their databases, will hound you day after day.

This is where Hiya (apple.co/2kl5Qsg, free) tries to help you out: it maintains a database that collates the numbers of

known spammers and scammers, and will warn you when one is trying to call: on the Phone app's incoming call screen, Hiya adds a yellow alert for spam calls from the likes of telemarketers and surveyors, or a red 'No entry' shield next to any number it identifies definitively as a 'scam or fraud' – and you have the option to block both and pass them to voicemail. This is possible thanks to CallKit, part of iOS 10 that enables third-party apps to augment your iPhone's call blocking and identification services.

You can also help boost Hiya's effectiveness: within the app, there's a page for reporting or blocking unwanted numbers; the info you provide there is sent back to Hiya's developer, which, after a number is reported enough times, will add it to the public database. That database is updated daily – and automatically, so

you don't have to worry about constantly installing app updates – so that everybody using Hiya is protected as quickly and easily as possible, all thanks to community efforts.

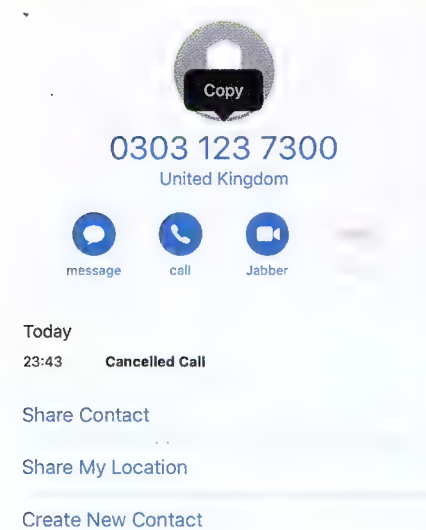
MAKE PREPARATIONS

One thing that might raise concern when you first open the app is that it asks for permission to access your contacts. According to Hiya's privacy policy, this is to "filter out numbers that may look spammy, but are actually legitimate (like your Doctor's office)".

After you've run through the app's intro, go to 'Settings > Phone > Call Blocking & Identification' and ensure the switch next to Hiya at the top of the page is on. Then read on to learn how to work with Hiya to avoid answering unwanted callers.

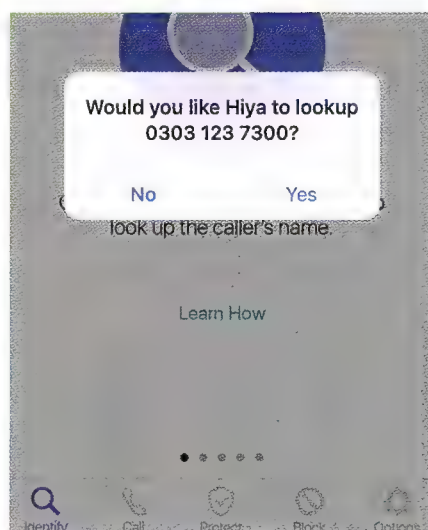
How to

Look up information about a number



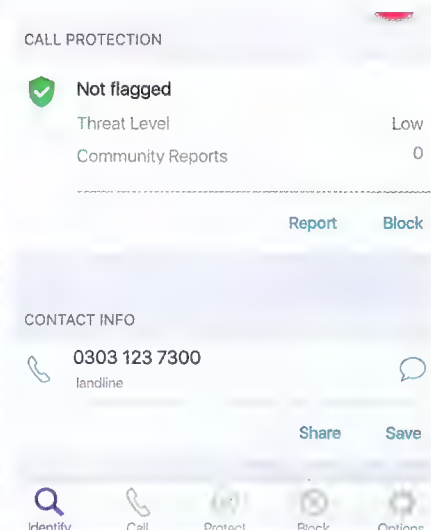
1 COPY THE NUMBER

To find out more information about a possibly fraudulent or spam call you've received, open the Phone app, go to the Recents tab, tap the circled 'i' next to the call, and then hold down on the number near the top of the screen to copy it.



2 PASTE IT INTO HIYA

Next, open Hiya. It should recognise there's a phone number on the Clipboard and ask if you want to look up its info; tap 'Yes' to go to the Identify tab. Otherwise, paste the number into that tab's search bar, then tap the suggestion to identify it.

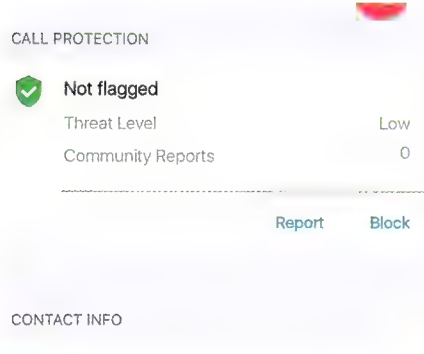


3 REVIEW THE CALLER'S INFO

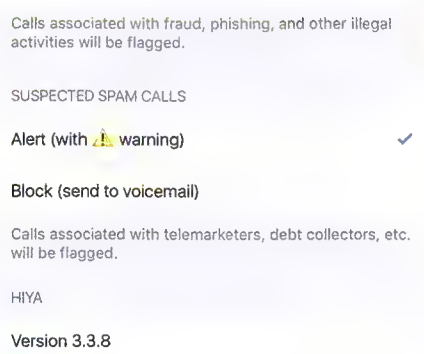
Hiya will search its database for any info it has about the number, such as whether it's a mobile or landline. It also gives you options to report or block the number, along with a summary of other people's previous experiences of it.

How to

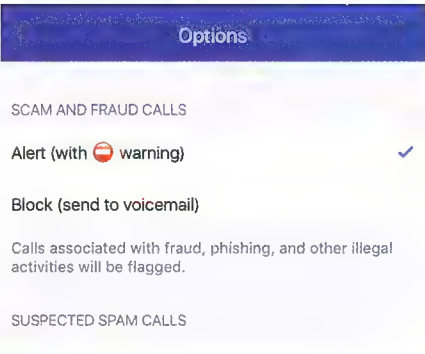
Tailor actions for spam and scam calls



1 EXPLORE HIYA'S OPTIONS
Go to Hiya's Options tab; this is where you can access the app's frequently asked questions (FAQ) page, contact its support team by email and, most crucial of all, tailor how you want the app to respond to suspicious calls.



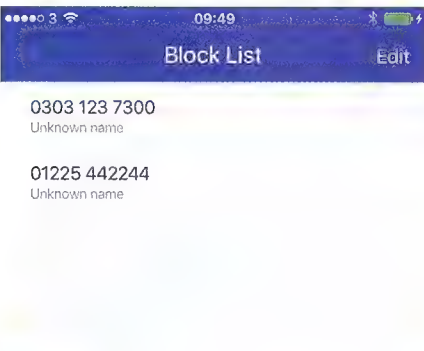
2 BLOCK SPAM
For low-threat calls (those classified as spam), you can choose whether Hiya should alert you by adding a yellow sign next to the caller ID on the incoming call screen, or simply block spam by default and direct it to voicemail.



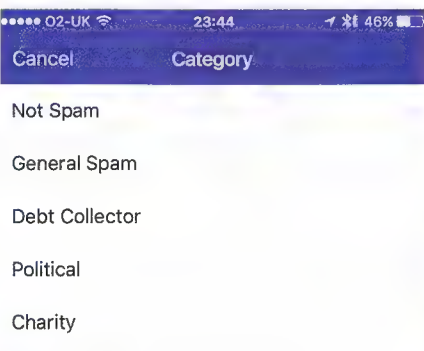
3 DEFEND AGAINST FRAUD
For calls that pose a higher risk to you, such as those from fraudsters or other malicious individuals, you can also choose to send them to voicemail too, or be given a clear warning with a red 'no entry' sign on the incoming call screen.

How to

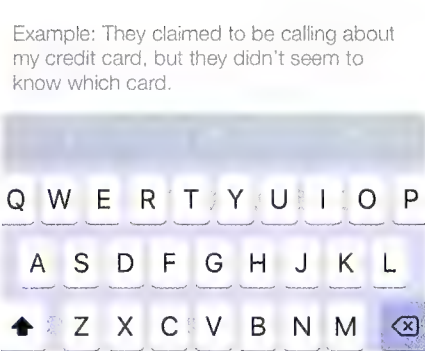
Take action over an unwanted call



1 REPORT A CALL
In the event you receive an unwanted call, it's time to take action. You have the option to report it to Hiya's developer in the Identify tab. You can also block the number from there, or go to the separate Block tab to manually add numbers.



2 CATEGORISE THE CALL
When you tap the Report button, you can choose from a list of categories so that Hiya can correctly classify the number. Or you can instead mark the number as Not Spam in order to improve inaccuracies in Hiya's database.



Example: They claimed to be calling about my credit card, but they didn't seem to know which card.

3 PROVIDE MORE DETAIL
Once you've chosen your category, you have the option of providing more specific details about the information the caller was trying to get from you, such as credit card information, or telling you to install harmful software.

Call Protection

Call Protection updated 1 minute ago

8,422 numbers added today. You are now protected from 70,186 unwanted callers.

[UPDATE NOW](#)

Add an extra layer of protection

A measure to keep your main number private.

Thousands of spammers and fraudsters are added to Hiya's database each day, so hopefully you'll find it useful in reducing the number of unwanted calls that you pick up. However, while Hiya can protect you from the symptoms of spam calls, ensure you also take steps against the cause. Try unlinking your number from social media accounts, or use an app like Sideline (apple.co/2kh99Dd) to provide you with a second phone number to use, which is especially helpful when you're unsure whether to give an organisation your main mobile number. ■

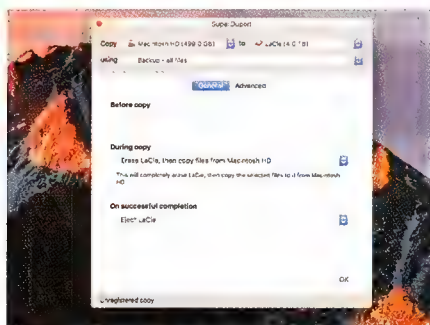
How to head-off and troubleshoot Mac problems

Fix common Mac problems with these advanced macOS tips.

Your Mac should give you years of trouble-free service, but things can and do go wrong sometimes — apps may crash, preferences may get corrupted and very, very rarely your Mac may exhibit more serious problems — such as refusing to boot up correctly. Outlined in the 18 tips below are fixes for some of the most common issues you're likely to face, including one of the most recent: dealing with unwanted Calendar invitations sent to you by spammers. For more help, go to support.apple.com/en-au/macOS.

1 MAKE AN EMERGENCY STARTUP DISK

Preempt the possibility that your Mac's startup disk may become damaged by turning a spare drive you don't mind wiping into an emergency startup disk. An 8GB or larger thumb drive, ideally USB 3, will do nicely. Follow the instructions at support.apple.com/HT201372 to create a macOS install disk, which you can use to install macOS over itself (retaining your personal files while potentially fixing damaged system ones), restore your Mac from a Time Machine backup, and access the same diagnostic tools available in macOS Recovery. To start up from this disk, hold Option immediately after powering on your Mac and select it from the available startup disks using the arrow keys and Return.



2 CLONE YOUR MAC'S STARTUP DISK

Particularly if you use your Mac to run a business and can't afford to sit through restoring it from a backup, consider buying SuperDuper (bit.ly/d8AWkD) and a spare external hard

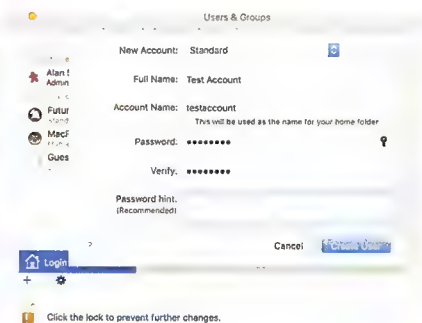
drive as large as your Mac's internal storage, and using SuperDuper to schedule a periodic, full clone of your Mac in its working state — perhaps once a week or month. Again, hold Option after powering on your Mac to choose this startup disk; you'll be able to access your Time Machine backups through it, too, enabling you to recover a more recent copy of what you're working on and be up and running again in a few minutes.

3 CHECK THE HEALTH OF YOUR MAC

If your Mac is behaving erratically, and especially if it becomes unexpectedly unstable — either shutting down, freezing or restarting of its own accord, or displaying a message like the one described at support.apple.com/HT200553 — try running the hardware diagnostic tools Apple provides with every Mac. These are hidden from plain sight, but can be accessed when powering on your Mac by following the instructions at support.apple.com/HT202731.

4 TRY A FRESH USER ACCOUNT

Check whether a problem exclusively occurs in your user account, which can happen as a result of a bad or damaged file belonging to it, by creating a new user in 'System Preferences > Users & Groups', signing in to that account and seeing if you can recreate the issue there.



5 TRY SAFE MODE

If your Mac fails to start up as normal, or if a problem while inside macOS Sierra affects all accounts, try starting up in safe mode, as described at support.apple.com/HT201262. This

mode disables third-party extensions, as well as other items that can cause problems around startup and logging in. If your problem disappears in this mode, you likely have a software incompatibility; make sure your apps, background services (notably those for peripherals) and macOS itself are up to date. Also check support forums for peripherals in case there's a known incompatibility with your current version of macOS.

6 CHECK YOUR MAC'S LOGS

If an app or a system feature such as Time Machine crashes unexpectedly, open Console (in /Applications/Utilities), select 'Diagnostic and Usage Data' on the left and scroll through the messages on the right to the time when the problem occurred. Though the statuses here can be difficult to decipher, they can provide just enough insight to help identify the root cause.

7 ONE OF YOUR APPS CRASHES ON OPENING

A likely cause of this is that the app's preferences file (belonging to your specific user account) is damaged. If the problem doesn't occur in a fresh user account, switch to Finder, hold Option and choose 'Go > Library', then open the Preferences folder within the folder that appears. Filenames here typically follow the format 'com.publisher.app.plist' — pinpoint the one for the faulty app, move it to the Trash (but don't empty the Trash), then try opening the app again.

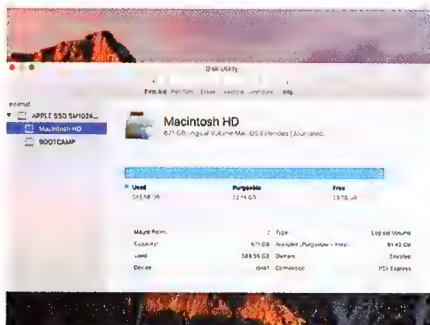
8 CHECK DISK STRUCTURES

Damage to the logical structures on your startup disk can cause problems. Restart in macOS Recovery, open Disk Utility, select your startup disk on the left, then click First Aid and allow this tool to inspect the disk. It'll attempt to repair any damage it finds.

9 A CURSORY DISK HEALTH CHECK

While in macOS or the Recovery system, open Disk Utility, select the drive on which your startup disk is stored (it'll be listed under Internal, with a disclosure triangle to its left), and then check whether its SMART status in the summary at the bottom

of the window says anything other than Verified – if so, that's a sign that the disk may be about to fail completely, so try to back up anything you're working on right now and seek professional help at an Apple Store or an Apple Authorised Service Provider. (See locate.apple.com/au/en for one near you.)



10 DO YOU SEE A FLASHING FOLDER AND QUESTION MARK AT STARTUP?

This is because your Mac is having trouble finding your chosen startup disk. There are numerous possible causes for this, including a bad setting in NVRAM (see below). Sometimes, this problem is temporary and entirely fixable by you, so the best first course of action is to follow the checks described at support.apple.com/HT204323.

11 STARTUP TONES

Many Macs emit a healthy chime noise if they pass power-on self tests, although some models released since 2016 (including the new MacBook Pro) are silent if tests are successful. If there's a serious problem, though, you'll hear a different sound. You can look up what those tones mean at support.apple.com/HT202768.

12 RESET NVRAM OR THE SMC

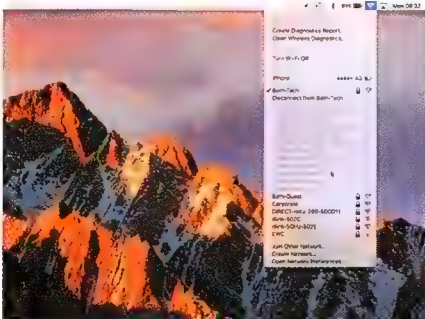
Your Mac stores certain fundamental settings, such as screen resolution, your chosen startup disk and its volume level, in a special area known as NVRAM (Non-Volatile Random Access Memory). Under specific circumstances, you may want to try resetting the contents of NVRAM. Read more about those situations at support.apple.com/HT204063. Similarly, unexpected hardware behaviour, such as the fans running full pelt, can require a reset of the System Management Controller (SMC). Additional scenarios and instructions on resetting the SMC are available at support.apple.com/HT201295.

13 GET YOUR MAC SERVICED

To avoid invalidating your Mac's warranty or AppleCare Protection Plan, it should only be maintained either by the Genius Bar at an Apple Store, or an Apple Authorised Service Provider. To find one that's near to you, start at locate.apple.com/au/en.

14 WI-FI RECEPTION IS VERY POOR

If it's OK in some parts of your home but not the place you need to work (which you can only easily test with a MacBook, of course), hold a while in both such locations and click the Wi-Fi icon in the menu bar. Contrast the RSSI, Noise and Tx (Transmission) Rate figures. In particular, RSSI is important – it works on a negative scale, and the closer to zero its value is, the better the signal strength. You'll probably find it's very low where your connection is bad, with Tx Rate also adversely affected, and possibly a very high negative value for noise impacting on your connection, too. You may need to install a Wi-Fi range extender and even power line networking adaptors to boost the signal strength in hard-to-reach parts of your home.



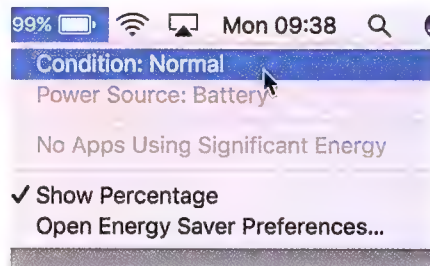
15 FORGOTTEN YOUR FIRMWARE PASSWORD?

In macOS Recovery, the Firmware Password Utility enables you to protect access to certain low-level functions, such as starting up from a different disk than usual or accessing the Recovery system itself (from which you can reset forgotten account passwords). Keep a copy of your firmware password somewhere safe, away from your Mac. If you lose the firmware password, you'll need to get help from Apple or a service provider – see support.apple.com/HT203409 for further details.

16 CHECK THE HEALTH OF YOUR LAPTOP'S BATTERY

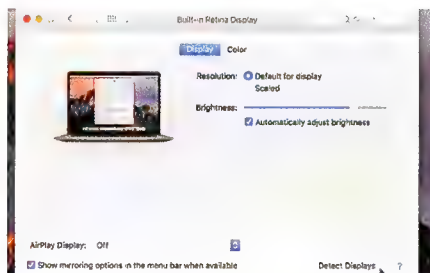
Modern MacBook, MacBook Air and MacBook Pro batteries are expected to last for many hundreds of recharge cycles. You can very quickly check whether your battery is seen by macOS

as in a healthy state by first turning on the battery icon in the menu bar (do so in the Energy Saver pane in System Preferences), then hold Option and click that icon; the top row of the menu will describe the battery's health. You can check the number of cycles your Mac's battery has gone through by following the guide at support.apple.com/HT201585 – further down that page, Apple lists the maximum cycle count for many Mac laptop models.



17 PROBLEMS WITH SECONDARY DISPLAYS

With the display plugged into your Mac, go to System Preferences' display pane, hold Option and click the Detect Displays button that appears at the bottom-left corner to force the Mac to recognise it. Apple offers additional advice about display connections and settings at support.apple.com/HT201177.



18 UNWANTED CALENDAR INVITATIONS

A growing problem shortly before this mag went to press is the receipt of event invitations from unknown people appearing in Calendar. It's best not to respond to these in any way, as doing so will alert the spammer that your email address is active. By the time you read this, the issue may have been resolved; Apple is implementing a Report Spam command in its Calendar app. Meanwhile, you can get safely get rid of unwanted invitations by doing this: choose 'File > New Calendar', then View > Show Calendar List', drag the unwanted event to the new calendar in the left pane, Ctrl-click the new calendar, and finally choose Delete. ■



Re-use an old Mac as a home server

Reuse a spare Mac for networked backups and to speed up iCloud Drive with Nick Peers.

Apple's commitment to its networking hardware seems to be at a halt, to the point that its AirPort team was recently rumoured to have been disbanded. With the future of AirPort Extreme and Time Capsule routers apparently under threat, you may be looking elsewhere for a device to centralise Time Machine backups for all the Macs in your home. Many third-party network drives come with Time Machine support, but you could press an older Mac into service instead.

The advantages of this are numerous. Firstly, you can plug in (and swap out) external storage, so you never have to worry about running out of room. Secondly, a USB drive represents much better value than a Time Capsule. Thirdly, external drives

perform much quicker when plugged directly into a Mac (particularly if it has USB 3.0) rather than going through the slower USB 2.0 port on an AirPort Extreme or Time Capsule.

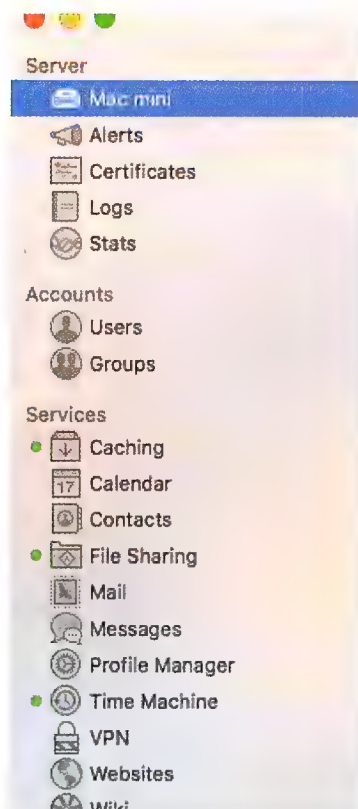
To do this, you'll need to purchase macOS Server (\$30.99, Mac App Store). This installs as an app within an existing version of macOS, and it comes with additional benefits too, from setting up centralised folder sharing to the caching of iCloud Drive data, which can save you time and potentially money if you're on a metered internet connection.

WHAT YOU NEED TO KNOW

Your Mac will need to be running OS X 10.11.6 (El Capitan) or higher to run the latest version of macOS Server, which might not be practical if you're using an older Mac. The trouble is that Apple

has made it difficult – but not impossible – to buy and install an older version of the app (which used to be more simply dubbed 'Server').

We're going to focus on Macs running OS X 10.8 Mountain Lion or higher, because that's the point where Server changed from being sold as a complete operating system to an app that runs on top of the regular one. If your old Mac is running either OS X 10.8 or OS X 10.9 (Mavericks), go to apple.co/2iAwmU4 and click the relevant link in the archived article. This will open the App Store and show you the correct version of Server for your system (2.2.5 for Mountain Lion; 3.2.2 for Mavericks) for you to buy or redownload if you bought it previously. Note that certain features – like caching personal data from iCloud Drive – aren't available in these earlier releases.



Mac mini

Overview Settings Storage Access

Host Name: Nicks-Mac-mini.local
Edit Host Name...

Computer Name: Mac mini
Edit Computer Name...

Internet: Reachable at 78.151.177.49, no services available
Last updated Today, 13:30.
Reachability Details...

Running for: 4 hours, 49 minutes

Version: macOS 10.12.2 (Build 16C67)
Server 5.2 (Build 16S1195)

The idea of running macOS Server may seem intimidating, but it offers a couple of features that are easy to set up and beneficial even in a home setting.

Things are a bit easier if your old Mac is running Yosemite. If you won't upgrade it to El Capitan, search the Mac App Store for 'macOS Server', then purchase it – you'll be told the current version isn't compatible and instead be offered the most recent version that will work. Accept this, and it'll download and install on your soon-to-be server.

Once the Server app is installed, you'll find it in the Applications folder. Before opening it for the first time, make sure the Mac's network connection is configured properly. First, we strongly recommend you

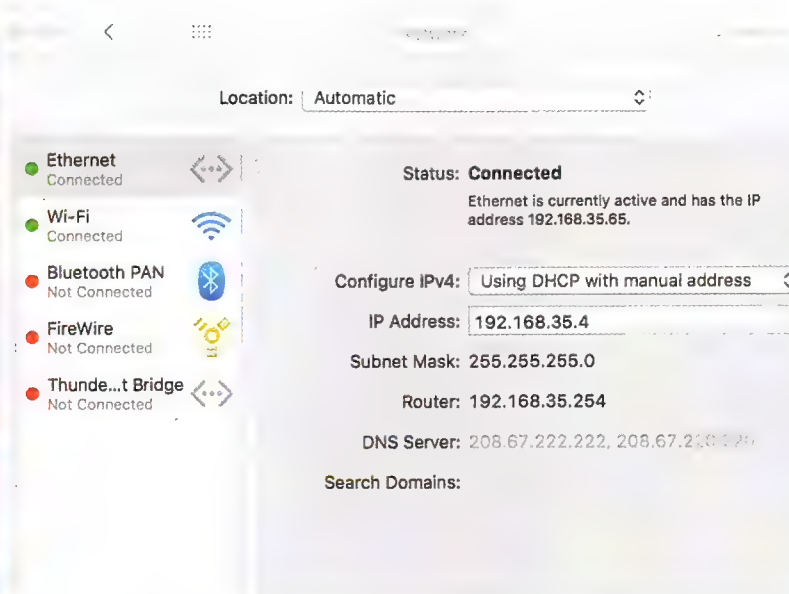
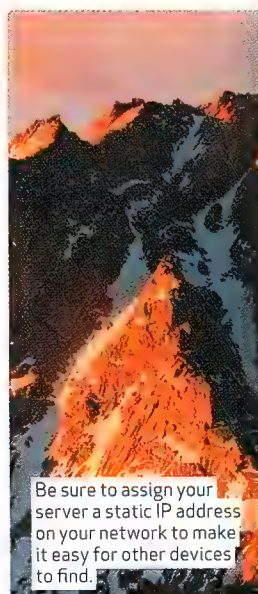
connect the server to your router using an Ethernet cable; while you can use Wi-Fi, Ethernet offers faster performance and a more stable connection.

Second, assign the server a static IP address on your network, so that it has a permanent identity that makes it easier for other Macs to locate and connect to it. To do this, go to 'System Preferences > Network', select the Ethernet connection if necessary, then change the 'Configure IPv4' pop-up menu to 'Using DHCP with manual address'. Next, give the Mac a static IP address; check the range

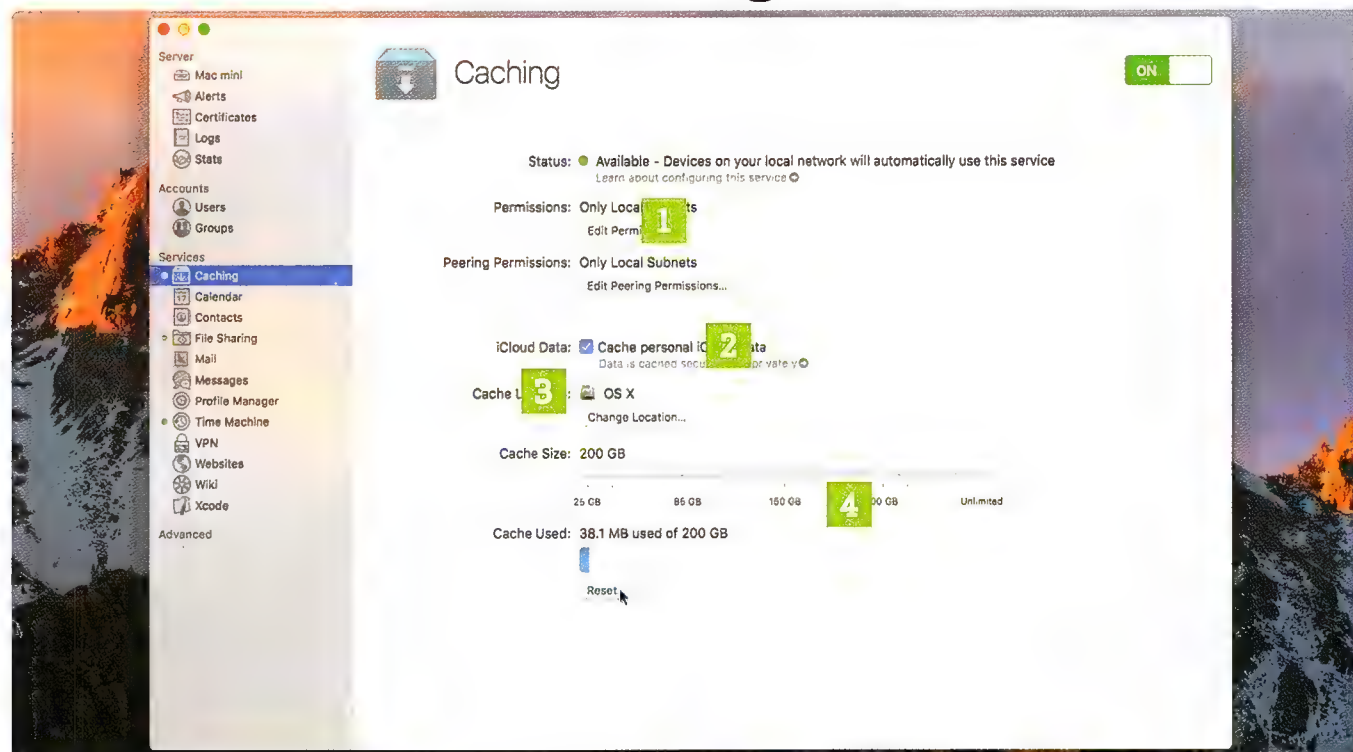
from which your router allocates addresses – often of the form '192.168.0.x', where 'x' is a number between 0 and 255 that isn't assigned to another device on the same network. When you've done that, click 'Apply'.

A LITTLE BIT OF BASIC SETUP

Server works best when you limit access to specific users and groups. Open the app and click Continue to set it up. Once done, you'll see its main screen, which gives an overview of the computer, and lists available services in the sidebar. Select Users under the Accounts heading on the left. You'll see



macOS Server's Caching feature



1 PERMISSIONS
By default, the cache works only for devices on your network; it's best, then, to leave these settings alone.

2 ICLOUD DATA
If you use iCloud Drive, check this box in order to speed up syncing its data among all your devices.

3 CACHE LOCATION
This setting enables you to pick an external drive with more space to store cached data.

4 CACHE SIZE
If space is an issue, use this slider to limit the cache's size. Clicking 'Reset' will clear the entire cache.

"The ability to cache iCloud Drive data is great if your broadband data is capped."

your own user account has already been added. Click '+' to add other members of your household.

You'll want to create accounts that match the ones on your household's Macs, so you may need family members to provide their account name and password — though not mandatory to match what they use on their own Mac, that simplifies matters. Make sure Home Folder is set to 'None — Services only'. We also suggest leaving the 'Allow user to administer this server' box unchecked, so you are the only person in control of your server.

Click 'Create'. By default, a new user will have access to all enabled services. If you want to restrict access, click a username, choose Edit Access to Services and then clear the checkbox next to any service you don't want that person to use. You can hold ⌘ to select multiple users, then click one of them and choose Edit Access to Services to apply the same rights to all of them at once.

SET UP SOME FEATURES

Follow the walkthrough opposite to set your server as Time Machine's target for Macs on your network. After that, your next task is to use Server's caching capabilities; macOS Sierra can put your Desktop and Documents folders in iCloud Drive to make it available on all your devices. If you have switched this on, you'll want to use iCloud caching to speed up syncing and cut internet bandwidth usage — crucial if you're on a metered connection.

The trick is to leave your server switched on 24/7, so whenever your other devices are connected to your network, any changes they make to your iCloud Drive are cached on the server, as well as uploaded to iCloud, and other devices on your network retrieve them from the cache rather than downloading them from the internet. When a device is away from your own network, or if your server isn't running, files will still sync with iCloud as normal.

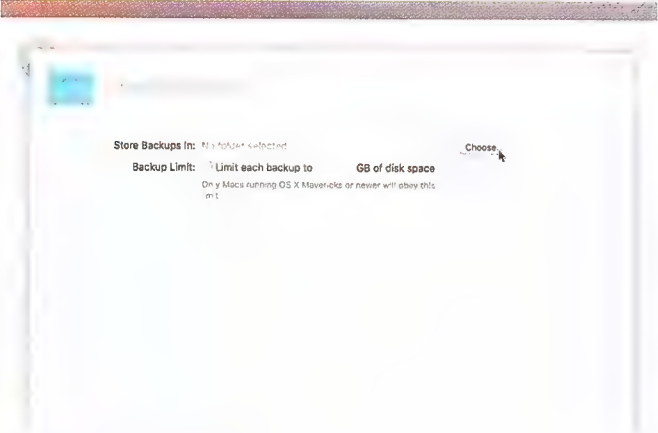
The benefits should be clear, and the more people who use iCloud Drive across multiple personal devices, the bigger the benefit. The annotation above shows how easy it is to set up the Caching feature. It also works for app purchases, iBooks, system updates and more (see apple.co/2jwJGJO), which can lead to further bandwidth savings and improved performance when your devices are able to retrieve data from the cache on your network.

Server is primarily aimed at businesses, yet it has other uses that may interest you at home or in a small business: creating wikis, centralising shared folders and using a virtual private network (VPN) to provide an encrypted connection to home over the internet.

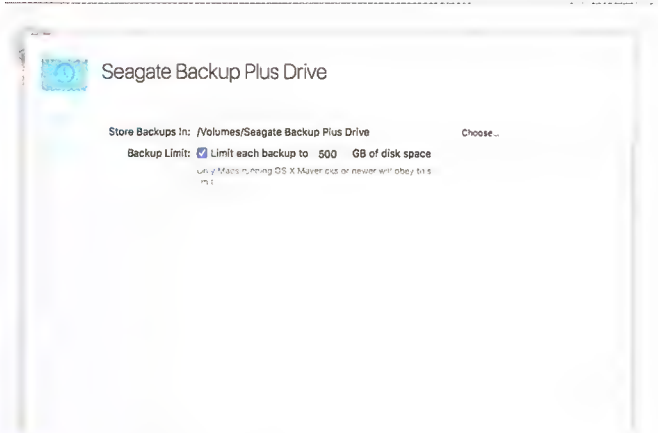
Even if you only want to back up your Macs wirelessly, and you have a spare one to run the app, the cost of Server and a hard drive saves you lots of money compared to an AirPort Extreme or a Time Capsule.

How to

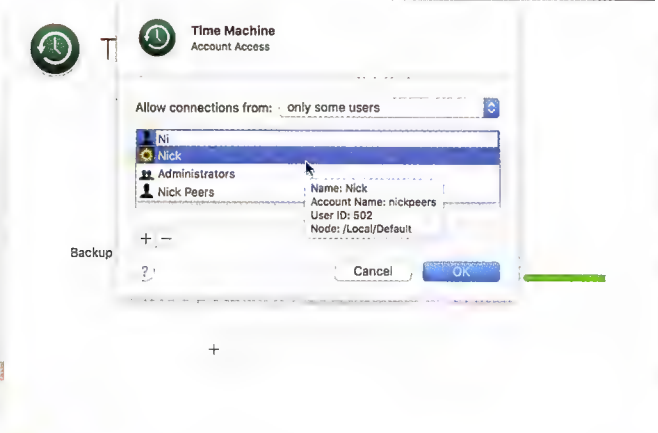
Set up Time Machine backups



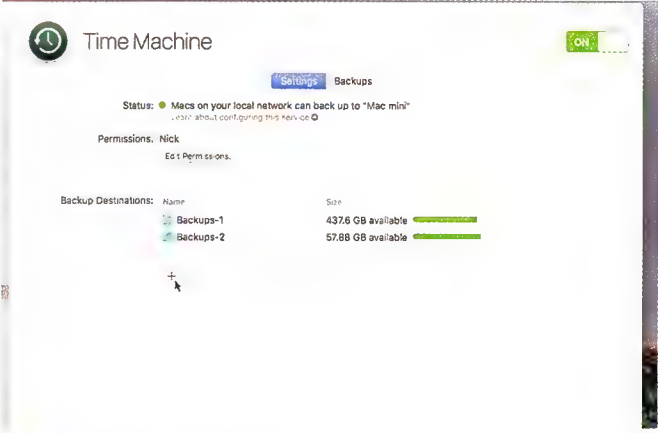
1 CHOOSE BACKUP DRIVE
Select Time Machine in Server's sidebar and turn on the switch (top right). You'll be asked to pick a destination in which to store backups of your other Macs. Click 'Choose' and select a folder on any connected drive



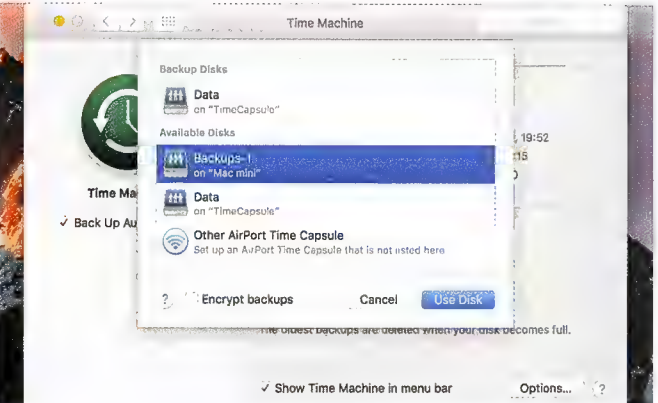
2 SET STORAGE LIMITS
If the server is using OS X 10.9 (Mavericks) or higher, you can cap the space available to each user. Check 'Limit each backup to' and enter a value; the lower it is, the fewer backups a Mac can keep before old ones are removed



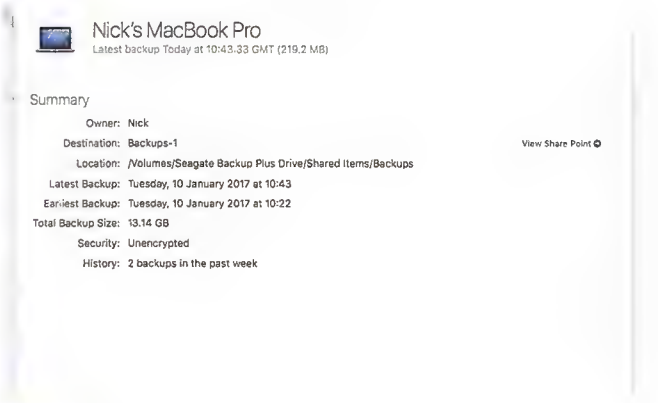
3 RESTRICT USER ACCESS
Another way to manage Time Machine is to limit which users can access it. Click 'Edit Permissions', select 'only some users' and click OK. Click '+' to add names — start typing, then select a user from the suggestions that appear.



4 ADD MORE STORAGE
Alternatively, if you start to run out of space, purchase another drive, connect it to your server and then click '+' under Backup Destinations to add its space, which will be used once the original drive is full.



5 CONNECT FROM OTHER MACS
In 'System Preferences > Time Machine' on another Mac, click 'Select Disk', select your server from the list of destinations, click 'Use Disk' and enter the username and password of the corresponding person's account.



6 MONITOR BACKUP USAGE
In macOS Server, select Time Machine, then click the Backups tab. A list of connected Macs and any ongoing or completed backups will be listed. Double-click one to reveal details, such as its history, or to delete backups.

Set up a Linux VPN server

Nick Peers shows how to create your own virtual private network.

Just how secure is your internet connection? The answer is often 'not very'. One of the most dangerous places to surf the web or check your email is via a public Wi-Fi hotspot. What you need is a guaranteed form of encryption to keep your business private, and that's where a virtual private network (VPN) comes in.

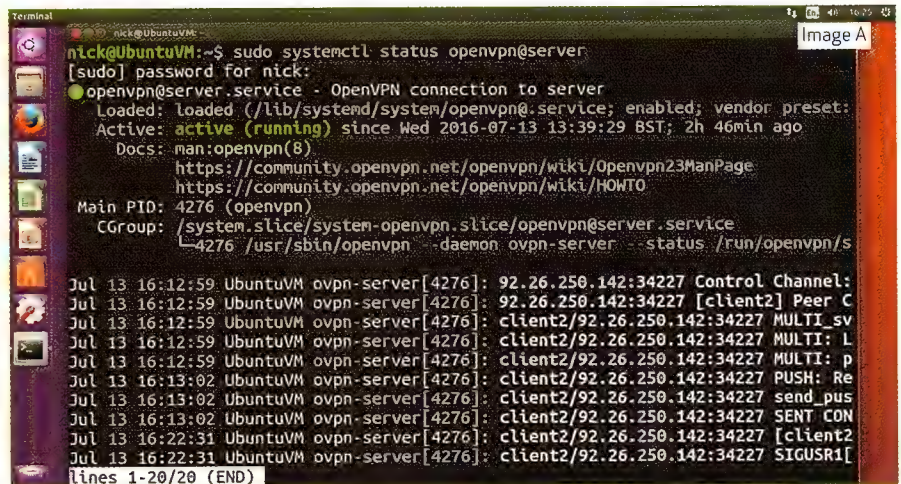
VPNs are designed to add an extra layer of security to the internet and other public networks. They basically create a secure 'tunnel', inside which all your data is encrypted before being sent over the network. Their main use for home users is to provide a secure connection to the internet, even over insecure networks. Commercial VPN services offer free packages, but these are slow and limited.

A much better option is to add your own VPN to your Linux computer for free. Thanks to OpenVPN, you can set up your own server, then configure it to provide one or more devices (mobile or computer) with a secure on-demand VPN whenever it's required. Without further ado, then, let's get started.

1 GETTING STARTED

The following tutorial works with your basic Ubuntu 16.04 install – the only real requirement is that your PC is on and connected to the internet at home whenever you want to employ your VPN's services abroad.

First, let's install OpenVPN Server. Although it's part of the official Ubuntu repositories, you can't install it through Software Center, so open a



```
nick@ubuntuVM:~$ sudo systemctl status openvpn@server
[sudo] password for nick:
openvpn@server.service - OpenVPN connection to server
Loaded: loaded (/lib/systemd/system/openvpn@server.service; enabled; vendor preset: Active: active (running) since Wed 2016-07-13 13:39:29 BST; 2h 46min ago
Docs: man:openvpn(8)
      https://community.openvpn.net/openvpn/wiki/Openvpn23ManPage
      https://community.openvpn.net/openvpn/wiki/HOWTO
Main PID: 4276 (openvpn)
CGroup: /system.slice/system-openvpn.slice/openvpn@server.service
        └─4276 /usr/sbin/openvpn --daemon ovpn-server --status /run/openvpn/s

Jul 13 16:12:59 UbuntuVM ovpn-server[4276]: 92.26.250.142:34227 Control Channel:
Jul 13 16:12:59 UbuntuVM ovpn-server[4276]: 92.26.250.142:34227 [client2] Peer C
Jul 13 16:12:59 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 MULTI sv
Jul 13 16:12:59 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 MULTI: L
Jul 13 16:12:59 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 MULTI: p
Jul 13 16:13:02 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 PUSH: Re
Jul 13 16:13:02 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 send_pus
Jul 13 16:13:02 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 SENT CON
Jul 13 16:22:31 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 [client2
Jul 13 16:22:31 UbuntuVM ovpn-server[4276]: client2/92.26.250.142:34227 SIGUSR1[
lines 1-20/20 (END)
```

Terminal window, and type the following:

```
# sudo apt-get update
# sudo apt-get install
openvpn easy-rsa
```

This installs two packages – the latter (easy-rsa) sets up and manages the certificates required to encrypt your network traffic. The easy-rsa package allows you to use OpenVPN in a PKI (Public Key Infrastructure), which consists of public and private keys for each server and client, with the public keys being used to identify trusted clients and servers to each other. These public keys are signed using certificates to verify their identity, and your server needs to be configured as a Certificate Authority (CA) to create, distribute and manage these certificates.

First job, then, is to set up your CA, and build the server's private and public keys – check out the step-by-step guide opposite for details. Once that process is complete, it's a good idea to 'harden' your VPN's security further with the following Terminal commands:

```
# cd ~/openvpn-ca
# ./build-dh
# openvpn --genkey --secret
keys/ta.key
```

2 CONFIGURE OPENVPN SERVER

Now it's time for the nitty-gritty: configuring your OpenVPN Server, and getting it up and running. First, you need to copy the encryption keys and other files you've just created to the '/etc/openvpn/' directory, again using the Terminal:

The make_config.sh script

Open up a Terminal, and then type the following command in order to create an empty file:

```
# nano ~/openvpn-ca/client-configs/
make_config.sh
```

Now you need to carefully enter the following lines:

```
#!/bin/bash
```

```
# First argument: Client identifier
```

```
KEY_DIR=~/openvpn-ca/keys
```

```
OUTPUT_DIR=~/openvpn-ca/client-
configs/files
```

```
BASE_CONFIG=~/openvpn-ca/client-
configs/client.conf
```

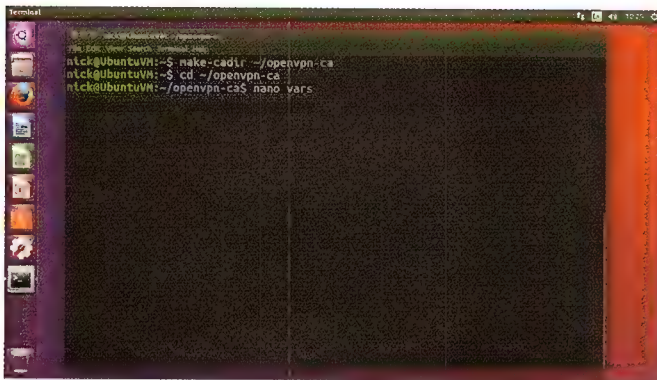
```
cat ${BASE_CONFIG} \
```

```
<(echo -e '<ca>') \
${KEY_DIR}/ca.crt \
<(echo -e '</ca>\n<cert>') \
${KEY_DIR}/${1}.crt \
<(echo -e '</cert>\n<key>') \
${KEY_DIR}/${1}.key \
<(echo -e '</key>\n<tls-auth>') \
${KEY_DIR}/ta.key \
<(echo -e '</tls-auth>') \
> ${OUTPUT_DIR}/${1}.ovpn
```

Once created, save and close the file, before typing the following command to make it executable:

```
# chmod 700 ~/openvpn-ca/client-
configs/make_config.sh
```

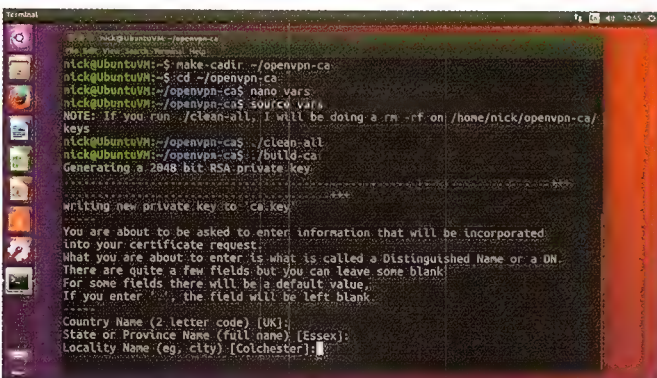

Set up your Certificate Authority



1 SET UP CERTIFICATE AUTHORITY DIRECTORY

First, you need to copy the easy-rsa template directory to your home directory, so your custom certificates aren't overwritten when the package is updated. So open the Terminal and type the following:

```
# make-cadir ~/openvpn-ca
# cd ~/openvpn-ca
# nano vars
```



3 BUILD CERTIFICATE AUTHORITY

At the Terminal, verify you're still in the openvpn-ca directory, then type: "source vars" and hit Enter. You should see a 'NOTE' appear (see screenshot). Now type "./clean-all" and hit Enter, followed by "./build-ca" and hit Enter. You're taken through the root certificate authority key and certificate. Hit Enter when prompted to confirm each edit you made in the previous step.

```
# cd ~/openvpn-ca/keys
# sudo cp ca.crt ca.key
MyVPN.crt MyVPN.key ta-key
dh2048.
```

```
pem /etc/openvpn
```

Replace MyVPN.crt and MyVPN.key with the value you allocated to KEY_NAME in the walkthrough above. Next, you need to generate your OpenVPN configuration file:

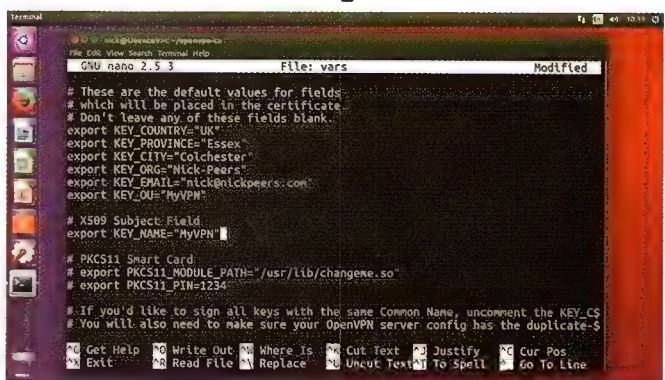
```
# cd /usr/share/doc/openvpn/
examples/sample-config-files
# sudo cp server.conf.gz /
etc/openvpn
# sudo gzip -d /etc/openvpn/
server.conf.gz
```

Now follow the second step-by-step guide (over the page) to configure your

server for basic usage. Once done, you need to perform one critical step to allow your clients to actually access the internet through your VPN. First, enter the following command:

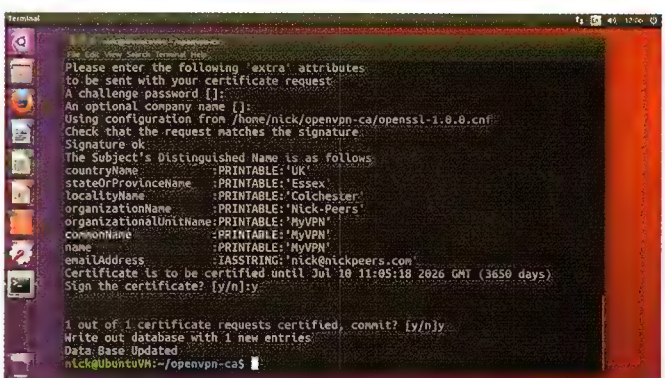
```
# ip route | grep default
Make a note of the interface listed next to 'dev' — on our machine, this is 'enp0s3'. Now enter the following command, substituting enp0s3 with the interface listed on your PC, if applicable:
# sudo iptables -t nat -A
POSTROUTING -s 10.8.0.0/24 -o
enp0s3 -j MASQUERADE
```

3 START AND TEST YOUR SERVER



2 EDIT VARS FILE

Scroll down to the group of lines beginning "export KEY_COUNTRY" and fill them in with your own personal information — see the screenshot for an example. Note "KEY_PROVINCE" should be filled with the state, such as 'Victoria' or 'Queensland'. Put your name or organisation in 'KEY_ORG' and fill 'KEY_OU' and 'KEY_NAME' with whatever you like, such as "MyVPN". Save the file ('Ctrl-O') and exit.



4 GENERATE SERVER'S KEYS

Type "./build-key-server MyVPN" and hit Enter, replacing 'MyVPN' with the value you entered for 'KEY_NAME' in step 2. Hit Enter to accept the default choices as before. When prompted to create a challenge password, hit Enter to leave it blank, and hit Enter again when prompted for an optional company name. Complete the process by pressing 'Y' to the last two prompts.

It's time to get things up and running. Type the following Terminal command, which launches OpenVPN using the server.conf file you've configured:

```
# sudo systemctl start
openvpn@server
```

Now check the server is running correctly:

```
# sudo systemctl status
openvpn@server
```

You should see a list of messages appear on screen, including the all-important 'active (running)' message [Image A], along with 'Initialization sequence completed' at the bottom — press 'Ctrl-C' to interrupt the status check. Next, check that the OpenVPN interface is available:

Configure your server

```

GNU nano 2.5.3 File: server.conf Modified

# and private keys. Remember to use
# a unique Common Name for the server
# and each of the client certificates.

# Any X509 key management system can be used.
# OpenVPN can also use a PKCS #12 formatted key file.
# (see "pkcs12" directive in man page).
ca ca.crt
cert MyVPN.crt
key MyVPN.key # This file should be kept secret

# Diffie hellman parameters.
# Generate your own with:
# openssl dhparam -out dh2048.pem 2048
dh dh2048.pem

# Network topology
# Should be subnet (addressing via IP)
# unless Windows clients v2.0.9 and lower have to.

Get Help Write Out Where Is Cut Text Justify Cur Pos
Exit Read File Replace Uncut Text To Spell Go To Line
  
```

1 DEFINE SERVER KEYS

Open the configuration file you've just created using `sudo nano /etc/openvpn/server.conf` at the Terminal. We're going to focus on the bare minimum settings required to get your server up and running. Start by scrolling down to the '# SSL/TLS root certificate...' section, and changing the 'cert server.crt' and 'key server.key' lines to point to the files you created in step four of the previous walkthrough.

```

GNU nano 2.5.3 File: server.conf Modified

# If enabled, this directive will configure
# all clients to redirect their default
# network gateway through the VPN, causing
# all IP traffic such as web browsing and
# and DNS lookups to go through the VPN
# (The OpenVPN server machine may need to NAT
# or bridge the TUN/TAP interface to the internet
# in order for this to work properly).
push "redirect-gateway def1 bypass-dhcp"

# Certain Windows-specific network settings
# can be pushed to clients, such as DNS
# or WINS server addresses. CAVEAT:
# http://openvpn.net/faq.html#dhcpcaveats
# The addresses below refer to the public
# DNS servers provided by openvpn.com
push "dhcp-option DNS 208.67.222.222"
push "dhcp-option DNS 208.67.220.220"

Search Wrapped
Get Help Write Out Where Is Cut Text Justify Cur Pos
Exit Read File Replace Uncut Text To Spell Go To Line
  
```

3 CONFIGURE WEB DIRECTION

These next tweaks instruct all connected clients to route their web traffic through the VPN. Press 'Ctrl-W' to locate 'redirect-gateway' and uncomment the line it's on: 'push...' Uncomment the next two instances of 'push' referring to DNS servers, as shown above. Finally, search for 'nobody' and uncomment the 'user nobody' and 'group nogroup' lines. Save and exit.

```
# ip addr show tun0
```

If it shows a configured interface ending with "valid_lft forever preferred_lft forever", things should be working correctly. You can now configure OpenVPN to launch automatically at startup with the following line:

```
# sudo systemctl enable
openvpn@server
```

4 MAKE CLIENT CONFIGURATION EASY

The simplest way to configure your client is through the use of specially made .ovpn files, inside which the required key files are embedded, along with the settings needed to connect.

These are created on your server, and here's what you need to do.

Create a directory structure inside which your client configuration files are stored, then lock down the directory permissions, and create a base config file to work from:

```
# mkdir -p ~/openvpn-ca/
client-configs/files
# chmod 700 ~/openvpn-ca/
client-configs/files
```

Now open the Nautilus file manager, click the 'Computer' link on the left and browse to '/usr/share/doc/openvpn/examples/sample-config-files'. Copy the client.conf file from here to '~/openvpn-ca/client-configs'. Double-click the copied file to edit it in gedit

```

GNU nano 2.5.3 File: server.conf Modified

# to help block DoS attacks and UDP port flooding.

# Generate with:
# openvpn --genkey --secret ta.key

# The server and each client must have
# a copy of this key.
# The second parameter should be '0'
# on the server and '1' on the clients.
tls-auth ta.key 0 # This file is secret
key-direction 0

# Select a cryptographic cipher.
# This config item must be copied to
# the client config file as well.
# cipher BF-CBC # Blowfish (default)
# cipher AES-128-CBC # AES
# cipher DES-EDE3-CBC # Triple-DES

Get Help Write Out Where Is Cut Text Justify Cur Pos
Exit Read File Replace Uncut Text To Spell Go To Line
  
```

2 IMPLEMENT EXTRA ENCRYPTION

Now press 'Ctrl-W' and type "tls-auth" — you're taken to a line marked '#tls-auth ta.key 0'. Remove the semi-colon from the beginning of this line (a process known as uncommenting) to enable it. Now add the following line underneath it, as shown in the screenshot above: "key-direction 0" — this ensures that the extra TLS authentication that you set up earlier is enabled for OpenVPN.

```

GNU nano 2.5.3 File: /etc/sysctl.conf Modified

#####3
# Functions previously found in netbase
#
# Uncomment the next two lines to enable Spoof protection (reverse-path filter)
# Turn on Source Address Verification in all interfaces to
# prevent some spoofing attacks
#net.ipv4.conf.default.rp_filter=1
#net.ipv4.conf.all.rp_filter=1

# Uncomment the next line to enable TCP/IP SYN cookies
# See http://lwn.net/Articles/277146/
# Note: This may impact IPv6 TCP sessions too
#net.ipv4.tcp_syncookies=1

# Uncomment the next line to enable packet forwarding for IPv4
#net.ipv4.ip_forward=1

Get Help Write Out Where Is Cut Text Justify Cur Pos
Exit Read File Replace Uncut Text To Spell Go To Line
  
```

4 ENABLE IP FORWARDING

Type "sudo nano /etc/sysctl.conf" and uncomment out the following line by removing the preceding '#' symbol from it:

```
#net.ipv4.ip_forward=1
```

Save and exit, then type the following command to reload sysctl: `sudo sysctl -p`. You should see 'net.ipv4 ip_forward=1' appear, indicating the setting has been correctly applied. That's it!

[Image B]. First, locate the line marked `remote my-server-1 1194` and change this to point toward your server's public IP address or dynamic DNS name — for example, `remote 1.2.3.4 1194` or `remote dynamic.ddns.net 1194`. Next, uncomment both `user nobody` and `group nogroup`, before commenting out the lines `ca ca.crt`, `cert client.crt` and `key client.key`, because they're added by the batch file. Last, but not least, add the following line beneath `tls-auth ta.key 1` (which should remain commented out): `key-direction 1`. Save and exit, then follow the instructions in the box

Set up your client

You can access your OpenVPN server through a variety of platforms — there's an official client for Windows, Android and iOS (visit www.openvpn.net for details), while macOS users can use Tunnelblick (www.tunnelblick.net). Transferring the .ovpn configuration file varies from device to device: you can simply copy the file to C:\Program Files\OpenVPN\config in Windows, for example, or double-click it to import it into Tunnelblick on macOS.

If you're running an Ubuntu client, you can install some additional packages and manage your connection through the GUI-friendly Network Manager. Open Terminal and type the following:

```
# sudo apt-get update
# sudo apt-get install network-
manager-openvpn-gnome
```

Once installed, open the Network Manager from the menu bar, select 'Edit Connections', then click 'Add'. Choose 'Import a saved VPN configuration...' from the drop-down menu and click 'Create'. Select your .ovpn file and click 'Open', then verify the settings are correct across the four tabs (click 'Advanced > TLS Authentication tab' to confirm it has also recognised the TLS key). Give your connection a more suitable name — the name you assigned your VPN under KEY_NAME, say — and click Save.

Once done, connect through the Network Manager's VPN submenu — you should see a lock appear over the menu bar's icon, indicating the connection has successfully been made. The final step is to open your browser to verify that the connection works.

on the first page of this article to create the 'make_config.sh' file, which you'll use to generate the client configuration files whenever they're needed for each client.

GENERATE A CLIENT CONFIGURATION FILE

You've now got all the tools you need to create your client configuration files. Here's the process you need to follow in order to build them. First, you need to generate a certificate and key for your client using the following commands:

```
# cd ~/openvpn-ca && source
vars
```

This time, ignore the note (we don't want to clean anything), then type:

```
# ./build-key client1
```

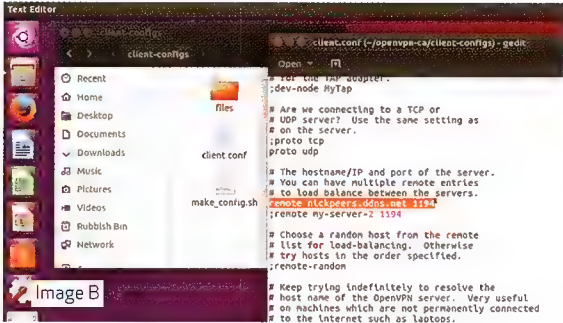
You need a unique name for each client certificate you generate —so, for

subsequent certificates, you would use client2 , client3 and so on. Again, you're taken through a similar process as when you ran the build-server-key command, and the answers are exactly the same — no challenge password, and accepting the default choices.

Once generated, build the configuration file:

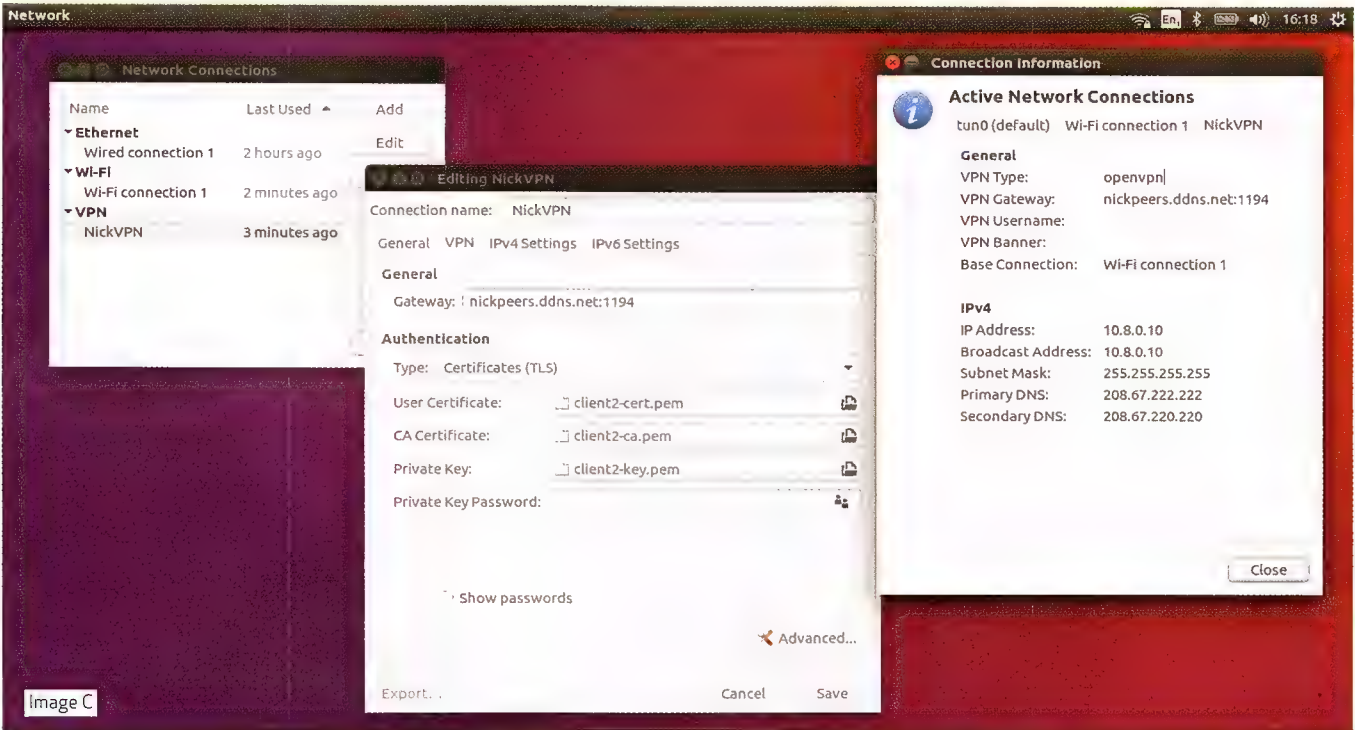
```
# cd client-configs
# ./make_config.sh client1
```

You'll find a file marked 'client1.ovpn' inside the client-configs/files subfolder. This now needs to be securely transferred to your client — the box above reveals the different



options available to you, and how to configure a VPN connection to your server from another Ubuntu PC.

Congratulations — you've just made your internet connection more secure [Image C]. ■





Kaby Lake for less

Is it time to ditch the old gaming adage? Zak Storey investigates.

THE CONCEPT

Since the launch of Intel's Core series processors, way back in 2009, there's been one simple rule associated with its mighty lineup of chips: If you're into gaming, to avoid bottlenecks, you're going to want to equip yourself with a Core i5, minimum. Four cores are king — any more, and you're wasting your hard-earned dollar; any fewer, and you're in for a world of frame rate hurt.

However, a lot has changed since 2009. And although the incremental processor performance increases Intel has staggered out of the gates since then have been somewhat lacklustre, cumulatively, they've provided us consumers with about a 70–80% increase in computational performance.

So we got to thinking... As game devs still haven't managed to take advantage of the multiple cores we already have, does that old saying still

ring true? Do you still benefit from having a quad-core, high-clocked i5 over a dual-core i3? Or have those IPC improvements led us into an age when you can get away with a cheaper Pentium for all your 1080p gaming needs? With Kaby Lake finally introducing hyperthreading on its Pentium range, allowing for dual-core and four-thread budget offerings, we decided to put it to the test in this quad-optional mid-range build.

CORE VARIANCES

Due to page layout restraints, we can't put all four variants of our system in the table on the right. However, as it's only the processor that changes during testing, we'll list them here.

Our base system features the Pentium G4600 listed in the table, with two cores, four threads and a 3.6GHz clock speed (no turbo) for a total of \$1,932. The next uses Intel's Core i3-7300, with two cores and four threads, still sans turbo, packing an impressive 4.0GHz, taking the total to \$2,078. The next step up is substantial: the Core i5-7600K, a four-cored, four-threaded turbo behemoth, capable of hitting 4.2GHz at stock, and bumping the price up to \$2,141. And finally, the Core i7-7700K. Four cores, eight threads and a 4.4GHz maximum turbo brings the total skyrocketing up to \$2,287 — a difference of \$355 from Pentium to Core i7.

We decided to take advantage of Corsair's Carbide 270R. This budget chassis checks all the boxes for our mid-range build. It's accessible, comes with just enough hard drive support to keep us happy, and provides a clean-looking aesthetic inside and out. Cooling support is strong, and the addition of a clean PSU cover made it a no-brainer. For GPU, we chose Nvidia's GTX 1060 6GB. We could have gone with an AMD RX 480 8GB, but the GTX 1060 provides more frames per dollar than the RX 480, so it wasn't a tough call to make. On top of that, two SSD hard drives and 16GB of DDR4 pull this beauty right into 2017 with a bang.

PARTS LIST

PART		STREET PRICE
CASE	CORSAIR CARBIDE 270R	\$89
MOTHERBOARD	GIGABYTE AORUS Z270X GAMING K5	\$280
CPU	INTEL PENTIUM G4600	\$120
MEMORY	16GB (2X 8GB) CRUCIAL TACTICAL @ 2,666MT/S	\$197
GPU	NVIDIA GEFORCE GTX 1060 6GB	\$379
PSU	CORSAIR RM650X	\$165
STORAGE 1	SANDISK ULTRA II 240GB SSD	\$119
STORAGE 2	CRUCIAL MX300 1TB SSD	\$399
COOLING	COOLER MASTER MASTERLIQUID PRO 240 & 1X CORSAIR ML120 PRO RED	\$194
TOTAL		\$1,942

"Do you still benefit from having a quad-core, high-clocked i5 over a dual-core i3? Can you get away with a cheaper Pentium for all your 1080p gaming needs?"



1 COOLING ISSUES

Cooler Master's latest 240mm AIO was a headache, as it deviates from the traditional Asetek mounting design. With most coolers, you secure the backplate to the motherboard using double-ended screws of varying sizes, depending on whether you're attaching it to a 2011 board, a 1150/51 board or an AMD offering. Then you place the CPU block on the four screws, and secure it with four thumb screws. With the MasterLiquid Pro, Cooler Master has removed the screw between the board and the backplate, so you have to position the backplate through the board, with long pre-attached screws. Then, while holding the backplate in place, you position the block on the screws. Finally, while somehow holding it so it doesn't move, you use the thumb screws to secure it. Pro tip? Find a buddy or, as we did, literally use your head to hold the block in place.



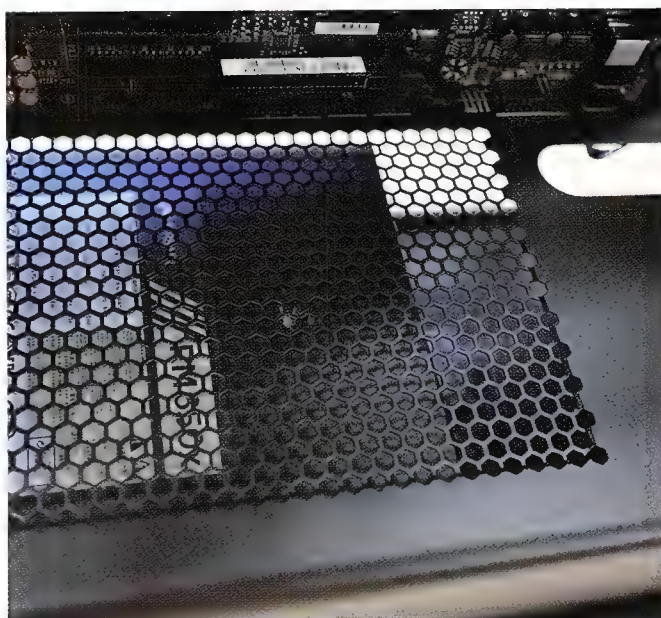
2 DUST CONUNDRUMS

One of the few complaints we have about Corsair's 270R stems from the uppermost fan mounts — primarily that they lack any form of dust cover. Being an awkward size and not supporting 360mm radiators either, regardless of its dimensions, makes things even more frustrating when you're on the hunt for a dust filter. Your best bet, if building in this particular chassis, would be to use two 120mm fans to blow air out of the top of the chassis. This should at least prevent too much dust entering your system while it's running, although it will need some loving maintenance to keep it truly clean in the long term.



3 GPU CABLE ISSUES

Oh, the problems of using bits and pieces from our storage cupboard: We wanted to use a custom cable kit in conjunction with our Corsair RM650X power supply, just to spruce it up a bit, but our only kit had already been cannibalised for our Dream PC from two issues ago (see 438, page 92), so there were only a few bits remaining. A single CPU power, one spare ATX power (specifically designed for the RMX, as the HXi has different 24-pin requirements), and a single GPU cable. The GPU cable in question, however, was a dual connector, so we were left with one part hanging out just below the GPU, which we couldn't hide around the back, or behind the cable cut-out situated below.



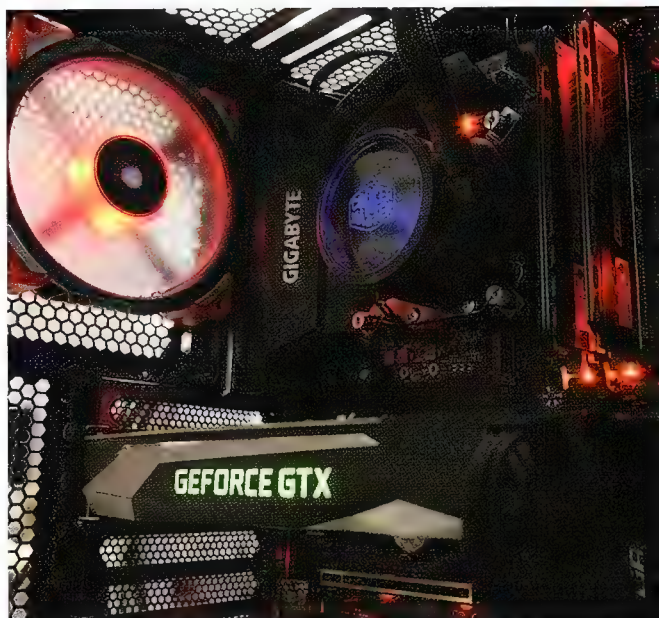
5 PSU COVER

Although Corsair still doesn't have quite as clean and beautiful a PSU cover as a lot of its competitors, it's damn good to see one included here. Three-quarter sized, it provides plenty of ventilation for multiple orientations of power supply, and easily lets us hide the vast majority of our excess cables below. One thing that still haunts us from our water-cooling days, however, is fan orientation. We always advise that you install your power supply with the fan facing down wherever possible, because a leak from the AIO or a GPU block, for instance, is likely to kill it.



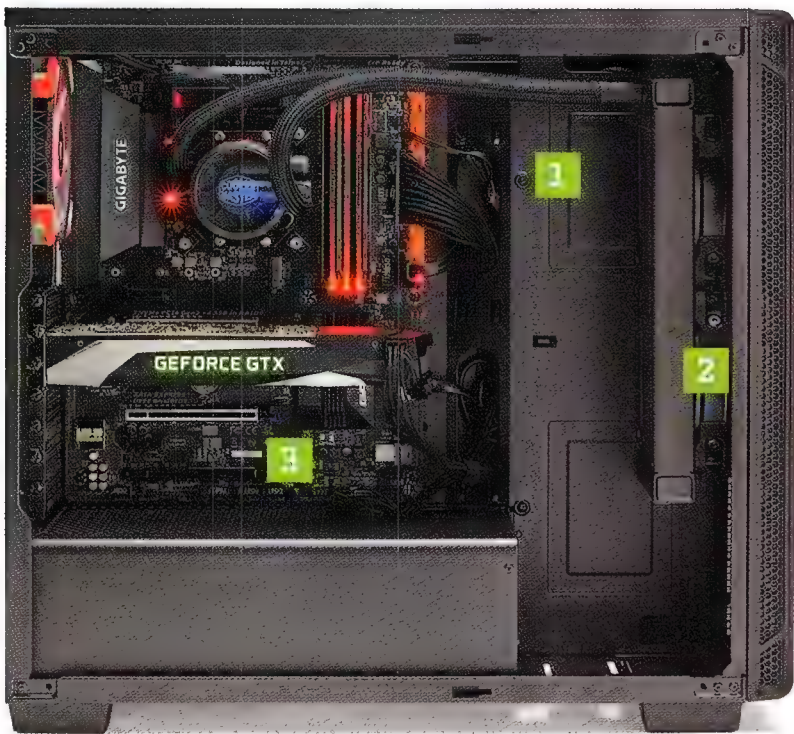
4 CABLE MANAGEMENT SORTED

We went all-out with this little build to get the cable management just right. Using a plethora of cable ties, we secured what we could to the back of the chassis, to make sure airflow wasn't restricted, and to ensure that the rear side panel was easier to replace — and, to be honest, to keep everything looking a little tidier. Take your time on this bit: Figure out which cables go under what, and where you can hide stuff, without it being too much of a major issue.



6 LED CORNUCOPIA

Colour coordination wasn't at the front of our minds when we built this machine, but we're actually quite impressed with how it turned out. We threw in a Corsair ML120 Pro in red in the back to spice it up a little, and help the air shift around efficiently inside, but the combination of the red motherboard with the blue cooler and green GPU actually kinda works, especially considering the price. You could install additional LED strips if you do want to change out to another colour — but, hooley, that's a lot of effort for not a lot of gain.



1 Although you can't see it from the front, it's entirely possible to mount two 3.5-inch hard drives in the back. Strip out the crazy 1TB SSD here and replace it with an HDD instead, and you could easily save \$200.

2 We had issues with the fans running in push configuration in this chassis. Cooler Master's fan design allows the fan blade unit to move forward, eventually scraping against the chassis at higher speeds. We added rubber spacers to stop this from happening.

3 Gigabyte's Z270X boards generally offer extra spacing between front panel headers, making it easy to identify where to install your power cables. Additionally, we never install the HD audio pass-through, because quality generally tends to be far worse than via the rear I/O.

The end of the road for the Core i5?

Well, there you have it, folks. Is this the end of the road for Intel's Core i5 series processor? Probably not. Legacies are always difficult to quash, and just as AMD's Ryzen has one hell of a stigma to overcome in the mind of the average PC enthusiast, so does the concept of the Core i5 not being the king of gaming.

Take a glance at the internet, and you'll see dozens of commentators purporting that the Core i5 is the way to go, and that even going up to the Core i7 isn't worth the cash, because you only gain 10% performance in games. The reality, on the other hand, is very different. Across the board, from one of Intel's lowest-priced chips all the way up to its mainstream rendering powerhouse, there's absolutely no difference in-game. It seems those IPC improvements have been making a difference to the

ecosystem after all – just not in the way we might think.

Building this particular system was actually considerably frustrating – mostly due to the cooler being so incredibly annoying to install. The backplate, coupled with the fans scraping the front of the chassis, and the pipes being far too resistant to movement, really gave us pause for thought as to whether this was the right cooler for us. We even had to unplug and reinstall the PWM pump fan header at first, because it refused to pump water around the system, forcing our Intel Core i7, that we tested first, to install Windows 10 on to the SSD at 99–100°C, at a paltry 200MHz. Although it was certainly impressive to witness, it was also excruciatingly frustrating.

Cooler problems aside, it turned out to be a pretty clean-looking build. Keeping all the storage around the back of the motherboard tray actually makes a world of difference. And although the PSU cover is only a 75% case fit, it does leave plenty of room for radiators and cooling up front, and it grows on you after a while.

Is there anything we would change? Well, if this were genuinely a build for purchase, not designed for that wide range of processor testing, we would probably drop the 1TB SSD in favour of an HDD, potentially go down to a B250 motherboard to save a bit of cash, use a lower specced PSU and potentially even 8GB of DDR4, depending on budget constraints. That would bring this particular build's price down considerably, perhaps even close to halve it. ■

BENCHMARK RESULTS				
	INTEL PENTIUM G4600	INTEL CORE I3-7300	INTEL CORE I5-7600K	INTEL CORE I7-7700K
CINEBENCH R15 SINGLE/MULTI (INDEX)	148/388	172/437	182/699	191/960
CRYSTALDISK QD32 SEQUENTIAL READ/WRITE (MB/S)	538/514	535/510	541/516	537/515
3DMARK FIRE STRIKE (INDEX)	9,179	9,542	10,606	11,184
DEUS EX MANKIND DIVIDED (AVG FPS)	25	25	25	25
RISE OF THE TOMB RAIDER (AVG FPS)	39	39	38	39
FAR CRY PRIMAL (AVG FPS)	66	67	67	67
ATTILA: TOTAL WAR (AVG FPS)	37	38	39	39
STEAM VR PERFORMANCE TEST (INDEX 0-10)	8.2	8.2	8.3	8.0

Best scores are in bold. All games were tested at the highest possible 1080p settings, bar *Deus Ex* (tested at Very High graphical profile).

Create a clever Pi wall calendar

Master your day with a Pi-powered organiser with Nate Drake.

One staple in futuristic films is that everyone has a handy panel on the wall showing their appointments for the day. While we have calendars on our smartphones and tablets, now, thanks to the Raspberry Pi, it's possible to have an economic wall-mounted calendar in your home or office.

Given that we have just admitted that we could, for instance, use a calendar app on our phones instead, is this just a novelty, or are there any advantages to doing this? Well, mounting your calendar on a wall is certainly more aesthetically pleasing than many smartphones, but the main advantage is that it enables you to share a calendar with others, by putting it in a public place, such as your living room. Your family can see your own appointments, and you can make sure you schedule your commitments around theirs. In the workplace, you can use calendar views, such as Agenda in Google Calendars, to organise meetings and assign tasks to colleagues.

1 CRAFTING YOUR CALENDAR

For this project, you need a Raspberry Pi with Internet access [Image A]. In the interests of saving on cabling and space, it's best to use the Raspberry Pi 3, which has integrated Wi-Fi.

You also need to choose a monitor. One excellent option is the Official Raspberry Pi Touchscreen Display (see 'Choosing a Monitor', opposite) but any compatible monitor will do. This isn't a DIY tutorial, so please only attempt to

mount the Raspberry Pi and display if you are comfortable with using a drill and installing brackets. If the display comes with a stand, there's no reason it can't be placed on a desk or table.

This is also a good time to start measuring cable lengths, so you can be sure both the monitor and the Pi will have power wherever they're mounted.

Once your equipment is in order, you need to consider the type of calendar you wish to use. If you and your family or colleagues already have a calendar you share, you can start following the tutorial right away.

If that's not the case, you may wish to create a single calendar for this purpose. If you're using Google Calendars, you can follow the steps at support.google.com/calendar/answer/37095?hl=en to do this. For Mac users, visit support.apple.com/kb/PH2674?locale=en_AU to create a new iCloud Calendar. Outlook users can also create a calendar by visiting calendar.live.com.

It's not particularly important which calendar service you use, provided it can be displayed in Mozilla Firefox, which we're using for this project. Try to give the calendar a distinctive name,

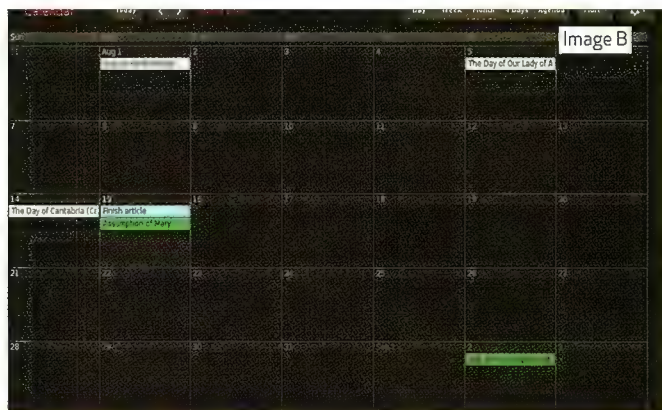
such as 'Smith Family Calendar', so everyone using it knows it's distinct from their personal calendar.

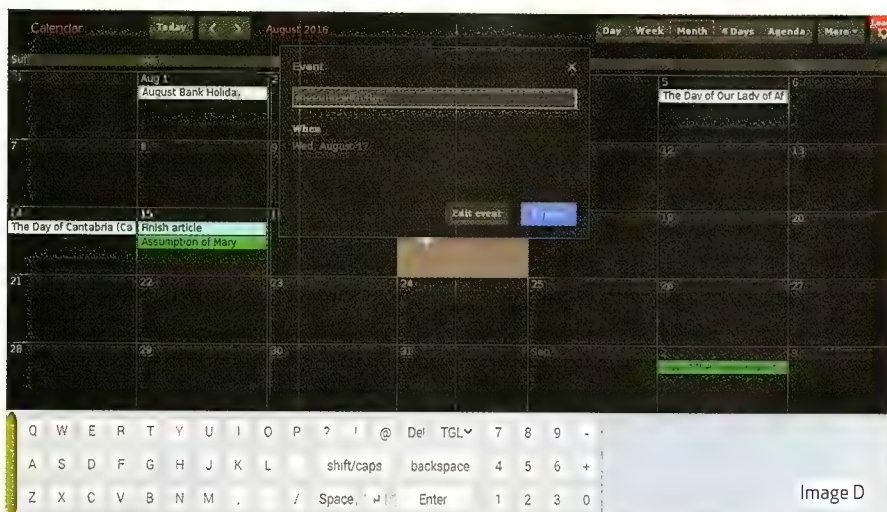
2 IMPORTING CALENDARS

If you do have an existing calendar, you may wish to import your personal appointments, birthdays and so on into the new one. It may not be necessary, because providers such as Google and iCloud allow multiple calendars. Events are colour-coded to show which calendar they belong to [Image B].

However, if one of the people using your new calendar previously used a different platform – for example, you have decided that you will all use a Google Calendar, but one person has been using an iCloud one on their iPhone – you need to import it.

To import events from an iCloud Calendar into Google, first export them into an ICS file by following the steps at support.apple.com/kb/PH11524?locale=en_AU. Then import the file by following Step 2 at support.google.com/calendar/answer/37118?hl=en.





To export a Microsoft Outlook Calendar to Google Calendar, follow the steps at bit.ly/2cl17IN.

3 CUSTOMISATION

Once you have a single, shared calendar, take some time to set it to a format with which you're comfortable. Most providers have the option of a daily, weekly or monthly view.

Next, feel free to fine-tune the appearance. You can make changes to the iCloud Calendar — for example, to change the viewable time period — by following the instructions at support.apple.com/kb/PH2678?locale=en_AU.

Google Calendar's default look and feel is rather spartan. If you would like to experiment with different themes, there's a number available from userstyles.org/styles/browse?search_terms=google+calendar. However, you need the Stylish Firefox extension

in order to install them, so visit addons.mozilla.org/en-US/firefox/addon/stylish/?src=ss, then click 'Add to Firefox' to install this.

4 FULL-SCREEN AHEAD

Because you'll be using a much smaller screen than you're used to, space will be at a premium, so consider installing the Real Kiosk (r-kiosk, addons.mozilla.org/en-US/firefox/addon/r-kiosk) add-on for Mozilla Firefox. Real Kiosk does what it says on the tin: It's designed to turn your browser into the equivalent of an internet kiosk.

This means the menus, toolbars and even the right-click function are disabled. The chief advantage of this is that Firefox always opens in full-screen mode, making your calendar much easier to see. This also makes sure your device can only be used as a calendar, because people trying

to view other websites are bounced back. If you do need to close down Firefox for any reason, you can do this by connecting a keyboard, holding down the Alt key, then pressing F4.

5 EDITING YOUR CALENDARS

Reading this project so far, it would seem that viewing the calendar in the web browser is a passive experience. However, if you have a central calendar on your wall, wouldn't it be ideal to let people add and edit appointments as well?

If you are using the official Raspberry Pi Touchscreen Display [Image C], tapping anywhere with your finger simulates moving the mouse and left-clicking in that place. You can use this to edit the time of events, and even create new ones.

Problems may arise when you want to edit the text of events or create names for new ones. Naturally, you could connect a small wireless keyboard, and leave it near the wall-mounted calendar in case data needs to be entered.

A much less clumsy solution, however, would be to have the keyboard built into the browser itself. The Mozilla Firefox extension VKeyboard [Image D] is designed for kiosk browsers, and pops up when clicked to allow users to enter text.

Simply visit addons.mozilla.org/en-AU/firefox/addon/vkeyboard/?src=search inside the browser, and click 'Add to Firefox' to install. If you have already installed the r-kiosk add-on, and can't change your web page, restart Firefox in safe mode, as outlined in the instructions at tinyurl.com/apc440-ffsm.

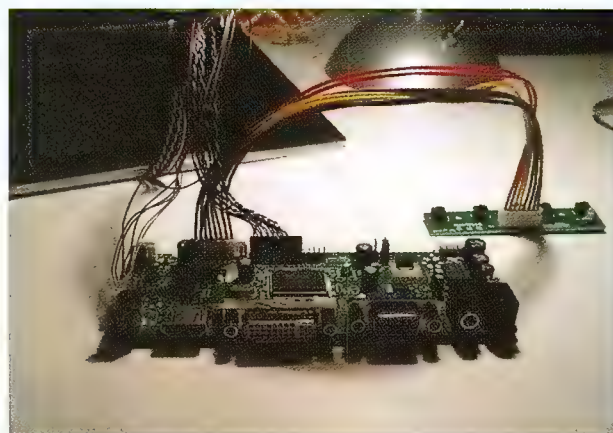
Choosing a monitor

There's no shortage of suitable small monitors to connect to your Raspberry Pi. If you feel comfortable with a small amount of wiring, the Official Raspberry Pi Seven-Inch Touchscreen Display is the ideal size to display a calendar, as well as having a handy slot at the back to place your Pi. The screen, along with assembly instructions, is available from the Adafruit website for about \$105 (www.adafruit.com).

If you don't like messy wires all over the place, Amazon sells a short micro-USB power cable for about \$5, to allow the Raspberry Pi to draw power from the monitor's USB port.

The Touchscreen Display has the added advantage of enabling you to scroll through appointments with a click of a finger. If this isn't important, or the display is out of your budget, Amazon and eBay also sell Pi-compatible displays. As the Pi has an HDMI port, any HDMI-compatible monitor will do, but some come with a driver board to allow you to connect it to the Pi's own DSI port.

If you are very comfortable with electronics, and want to save money, find a broken-down laptop with a working LCD. If you can remove the screen safely and buy a compatible controller



board online, it can be made to work with the Raspberry Pi. Visit www.instructables.com/id/Old-laptop-screen-into-Monitor/?ALLSTEPS for some tips.

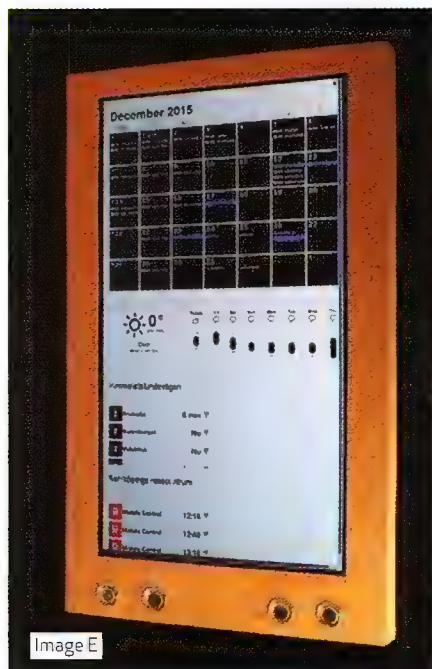


Image E

6 SHARING THE DATES

If you want to use any device besides the Pi to add or change appointments in Google Calendar, you either need to sign into your Google or iCloud account on that device, or share your calendar with others.

To share your Google Calendar, follow the steps at support.google.com/calendar/answer/37082?hl=en. You can send a link to only certain email addresses, or make the calendar viewable to anyone with the link. You can do the same for iCloud Calendars by following the steps at support.apple.com/kb/ph2690?locale=en_AU.

If you use Outlook 2010, it's also

possible to publish a calendar to Outlook.com by visiting tinyurl.com/apc440-outlook, and following the section entitled 'Share a Calendar by Publishing it Online'.

Once your calendar has been shared online, people who wish to edit it need to access it from their own devices. For anyone with a computer, this is a simple matter of visiting the link, as you would on the Pi, by using their browser.

It's also possible to view and edit the calendar on smartphones. If the shared calendar is with Google, Android users can access it from their own calendar app, even if they have a different Google account, by following the instructions at tinyurl.com/apc440-android. There is an official Outlook app for Android, which allows for easy viewing and editing of Outlook calendars. Sadly, iCloud Calendars aren't so easy, but there's a number of third-party apps, such as SmoothSync, in the Google Play store, which enable you to synchronise between calendars.

If you are an iPhone user, you're in luck. There's an official Google Calendar app in the iTunes Store, with which you can sign in and view your calendars. There is also an official Microsoft Outlook Email and Calendar app, which can be used to view and edit Outlook Calendars.

7 CALENDAR CONUNDRUMS

If you create or change an appointment, and it doesn't appear right away on everyone's device, wait for 5-10 minutes before attempting troubleshooting, to let it percolate through. If the changes are visible on the wall calendar — that is, on the website — the issue is most likely to do with the device, not the Raspberry Pi.

The software and add-ons used to

view the calendar are very easy to install, so the most problematic part of this project is likely to be when it comes to adding the monitor, and fixing it to your wall (Image E).

You can make life much easier for yourself by buying a monitor specifically designed for the Raspberry Pi, so you have somewhere to put the computer itself. If the place you want to install the wall calendar is hard to reach, you may be able to buy a longer micro-USB cable, but bear in mind that the voltage drops as cable length grows. Consider using shorter cables and/or a powered USB hub.

If the Raspberry Pi crashes for any reason, Firefox tries to restore all open web pages once it reboots, which may mean you have to plug in a mouse or keyboard to close down any extra tabs.

You can reduce the chance of this happening by starting Firefox in safe mode, and then entering 'about:config' in the address bar. Press Return to be taken to the settings screen for Firefox. Once you're there, simply scroll down to the setting marked 'Browser.sessionstore.resume_from_crash' and double-click to change from 'True' to 'False'.

If you're using Google Calendars, anyone who scrolls to the top of the screen can switch from your calendar to your other Google Apps, such as Gmail. They can also use the search bar to view documents stored in your Google Drive.

If this concerns you, consider setting up a dedicated Google account, just for the calendar. You can still access and edit the calendar from your own account.

Calendar tweaks & tips

When the calendar is on your wall, the cursor can look untidy, especially when using a touchscreen. A handy app called Unclutter can hide the cursor except when it's being moved or you're touching the screen. Open Terminal on your Pi (or connect via SSH), and run the command:

```
sudo apt-get install unclutter
```

In case the Pi crashes, and you're forced to reboot, it's best to have Firefox programmed to open automatically, saving you the trouble of reconnecting a keyboard and mouse. Open Terminal on your Pi (or connect via SSH), and run the command:

```
sudo nano /etc/xdg/lxsession/LXDE-pi/autostart . Scroll to the bottom of the window and add the line @firefox-esr . Press 'Ctrl-X', then 'Y', then Return to save your changes.
```

Finally, to make sure the display doesn't sleep after a few minutes, open Terminal or connect via SSH once again, and run the command: `sudo nano /etc/lightdm/lightdm.conf`. Scroll down to where it says '#xserver-

command=X' and remove the hash at the start of the line. Next, put a space after the letter 'X' and type "-s 0 -dpms". Press 'Ctrl-X', then 'Y', then Return to save your changes, then reboot your Raspberry Pi.

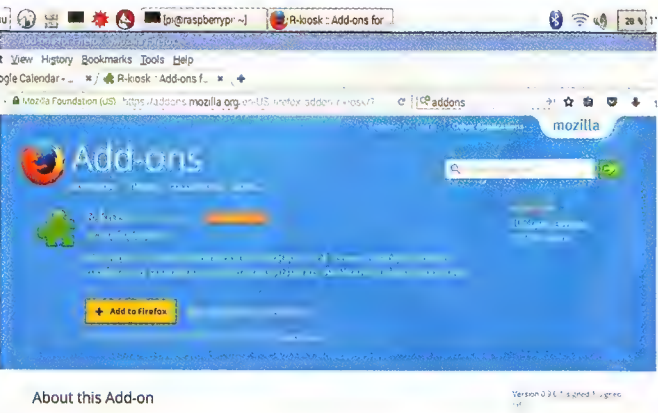
If you are using Google Calendars, click the arrow beside 'Other Calendars', then 'Browse Interesting Calendars' to see a list of calendars to which you can subscribe — for example, Holidays in Ireland. Click 'Subscribe' to have them appear on your own calendar.

S	M	T	W	T	F	S	
31	1	2	3	4	5	6	
7	8	9	10	11	12	13	7
14	15	16	17	18	19	20	
21	22	23	24	25	26	27	
28	29	30	31	1	2	3	
4	5	6	7	8	9	10	
My calendars							1
Other calendars							
Holidays in Ireland							2

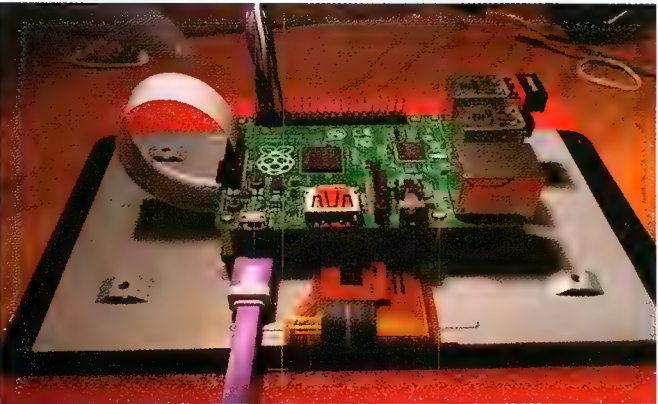
Set up your wall calendar



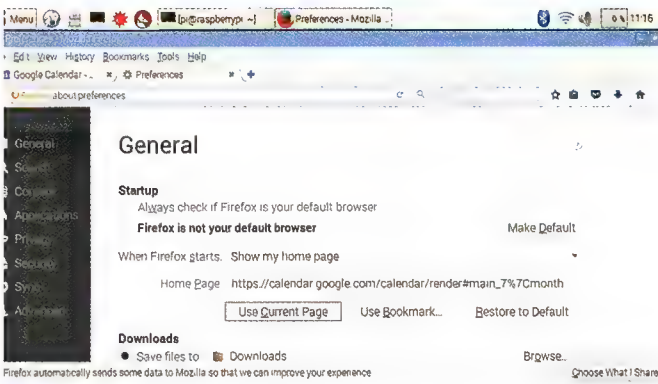
1 UPDATE RASPBIAN AND INSTALL FIREFOX
Before you can physically transform your Raspberry Pi into a wall calendar, you need to connect the device to the internet, and open the Terminal app. Run `sudo apt-get update` and then `sudo apt-get upgrade` to bring your RPi up to date. Next, enter `sudo apt-get install iceweasel` to install Firefox Extended Support Release on to your mini computer.



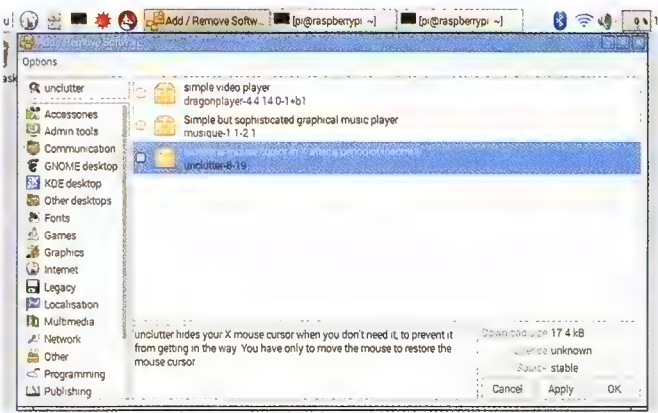
3 SET FIREFOX FOR FULL-SCREEN
This step is optional but recommended. Visit addons.mozilla.org/en-US/firefox/addon/r-kiosk to install the Real Kiosk add-on — this disables menus and toolbars. Firefox needs to restart for it to work. Remember, you can still close the window by connecting a keyboard to the Raspberry Pi and pressing 'Alt-F4'.



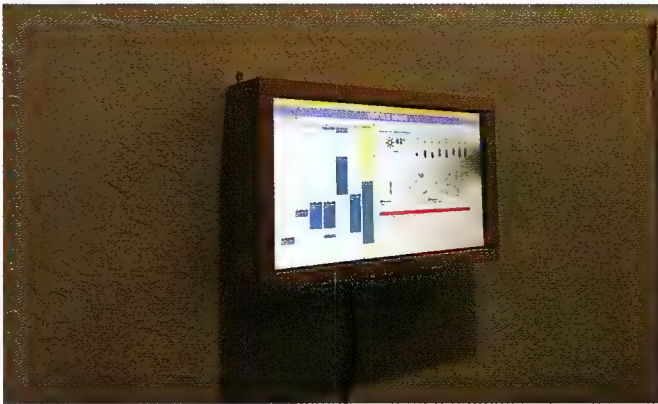
5 CONNECT IT UP
The specific steps to connect your monitor vary from device to device. If you are using the official Raspberry Pi Touchscreen Display, assembly instructions are available from The Pie Hut, tinyurl.com/apc440-pihut.



2 SET FIREFOX PREFERENCES
Go to 'Menu > Internet > Firefox ESR' to open Firefox. Visit your calendar address — calendar.google.com, for example — and sign in if necessary. If Firefox prompts you to remember your preferences, say 'Yes'. Once you can see your calendar, go to 'Edit > Preferences' and click the 'Set to Current Page' button to make sure Firefox always displays the calendar.



4 PERFORM TWEAKS
Make sure the calendar is in the view you want — for example, Monthly. Next, follow the steps in the 'Calendar Tweaks and Tips' box (opposite) to hide the mouse when not in use, disable the RPi's sleep function, and make Firefox start every time you switch on the machine, if you wish. Restart the RPi to ensure your changes have taken effect.



6 FINISHING TOUCHES
Once you've connected your Raspberry Pi up to a screen, you'll want to position it somewhere that everyone can access. If it's in your home, you'll probably also want to make it look as good as possible. You can let your imagination run wild here — take a look online to see what other people have achieved. ■

Google goes IoT with Android Things

The Internet of Things is booming, but so are its security concerns. Can Google fix it all with its new Android Things? Darren Yates investigates.

For the first time, 2017 looks likely to be the year there are more Internet of Things (IoT) devices connected to the web than there are people on the planet, with market analyst firm Gartner forecasting IoT numbers to exceed 8 billion by the end of the year, up more than 30% on 2016. But that isn't the half of it – by 2020, IoT numbers are expected to skyrocket to 20.4 billion (tinyurl.com/hd8b9l8). With growing global concern over IoT security, these are numbers likely to make security experts wince.

Already, we've seen a number of major distributed denial of service (DDoS) attacks involving IoT devices, including the attack on domain-name server (DNS) supplier Dyn in October 2016, reportedly launched by IoT devices hacked with the Mirai botnet malware code (tinyurl.com/jte7v5r).

With that as the landscape, Google has tweaked its Android operating system to launch a new IoT-specific OS called Android Things – could it be the answer to all that ails IoT?

PROJECT BRILLO

Android Things began in 2015 as Project Brillo (tinyurl.com/gwplaw), described at the Google I/O conference that year as a 'polished down' version of Android, stripped back to just the kernel (the core engine) and the minimum abstraction layers required to offer the key features Google named as 'minimal system requirements', 'broad silicon support' and 'be easy to secure'.

While Brillo was built on Android, it wasn't really Android. For starters, Google replaced the usual Java application framework, choosing instead C/C++, the language commonly used to code IoT devices powered by low-power processors called 'microcontrollers' (we code microcontroller projects using Processing, a simpler language derived from C++, in our monthly Arduino Masterclass).

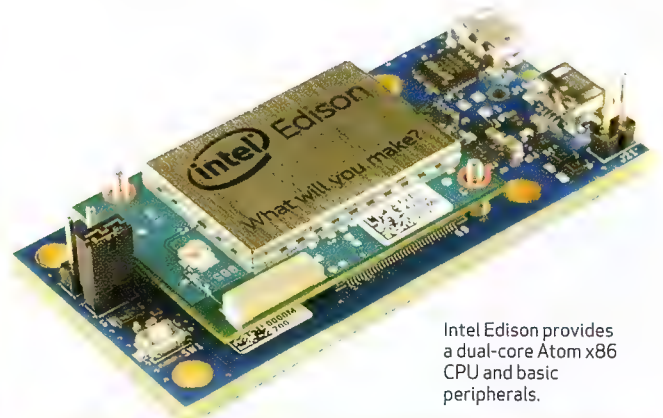
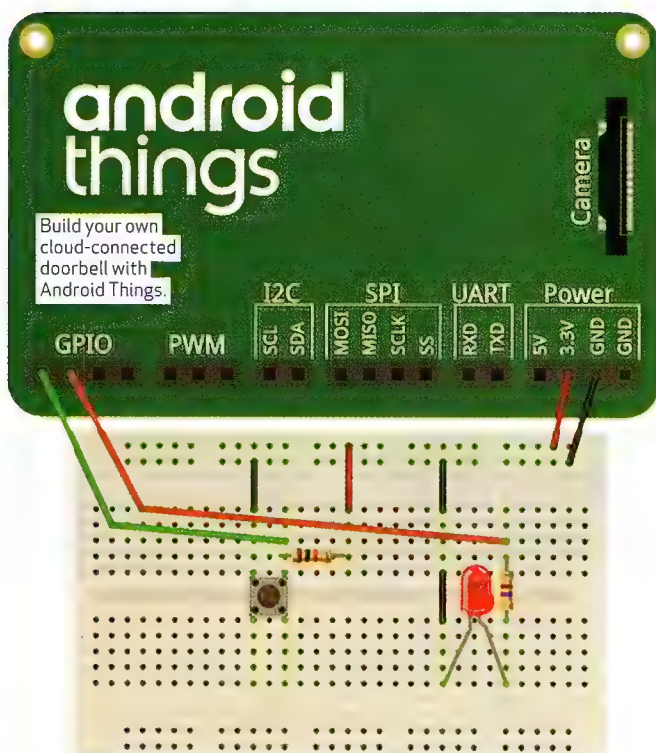
Brillo also included the new Weave protocol, enabling Brillo-powered devices to talk not only to your Android phone or tablet, but to each other, using

application programming interfaces (APIs) available to IoT app developers.

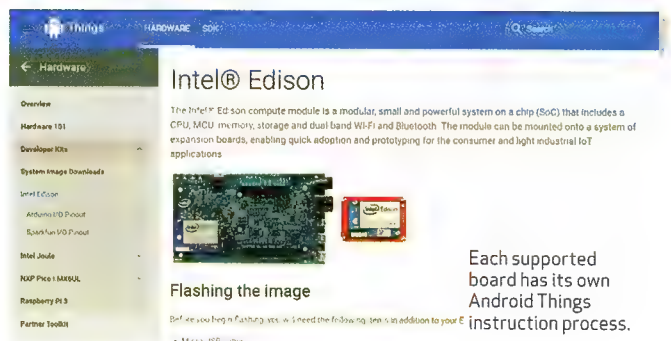
It was commonly reported at the time that Brillo would power devices with as little as 32MB of RAM; however, this was seemingly never confirmed or denied by Google. Nevertheless, the IoT-focused OS began reaching developers by invitation in October 2015. By January 2016's Consumer Electronics Show (CES), it had gained some big-brand support from names such as LG, ASUS and Marvell (tinyurl.com/j86h2nq).

ANDROID THINGS LAUNCHED

But a year is a long time in tech and, in December 2016, Google had rebadged Brillo, announcing the Android Things platform with a developer preview and recently releasing 'Developer Preview 2' (tinyurl.com/hs76ufx). At time of writing, four hardware platforms were now supported – Intel's dual-core 500MHz Atom-powered Edison, the quad 1.7GHz Atom-cored Intel Joule, NXP's Pico i.MX6UL with its single-core 500MHz ARM Cortex A7 SoC,



Intel Edison provides a dual-core Atom x86 CPU and basic peripherals.



Each supported board has its own Android Things instruction process.

Intel's most recent quad-core Atom development board called Joule.



plus the famed Raspberry Pi 3 with 1GB of RAM and quad-core Cortex A53 SoC. More hardware platforms could receive support by final release.

Android Things shows a number of changes from Brillo, whether as the result of internal discussions or from developer feedback. Whatever the case, gone is C/C++ as the primary coding language and back comes Java. While this might offend some IoT purists, Java – as the default language of an Android-based platform. The other notable difference, from the initial rumours at least, is the apparent minimum hardware level required, with NXP's Pico i.MX6UL having the smallest RAM cache at 512MB – a long way from those '32MB' rumours.

SOFTWARE DEVELOPMENT

However, the broad switch from C/C++ to Java will allow Android developers to write familiar code using the existing JetBrains-powered Android Studio development environment. If you're interested in the 'developer preview', there isn't much at time of writing that's specifically 'Android Things' in terms of coding. Apart from requiring Android Studio 2.2 or later, you need to install a minimum of Android Nougat/7.0 SDK (software development kit) and Android SDK Tools version 24 (tinyurl.com/jh6wh5n). After that, you create a new project that targets at least Nougat/7.0 and add the Android Things library in the app-level build.gradle file, using the code:

```
provided 'com.google.android.
things:androidthings:0.1-
devpreview'
```

...within the dependencies group. You then add the shared library to your app's manifest using:

```
<uses-library
android:name="com.google.
android:things"/>
```

The International Energy Agency calls IoT power load 'significant'.



But the real key is the Android Things OS you install onto your IoT development board. This was available at time of writing as ‘system image’ previews from Google’s Developer website (tinyurl.com/h54xcyg) at approximately 250MB each. Ensure you download the file that corresponds to your development board. The process of installation is different for each of the currently supported boards, but generally follows traditional methods, for example, Win32DiskImager to write Raspberry Pi 3 images to microSD card and

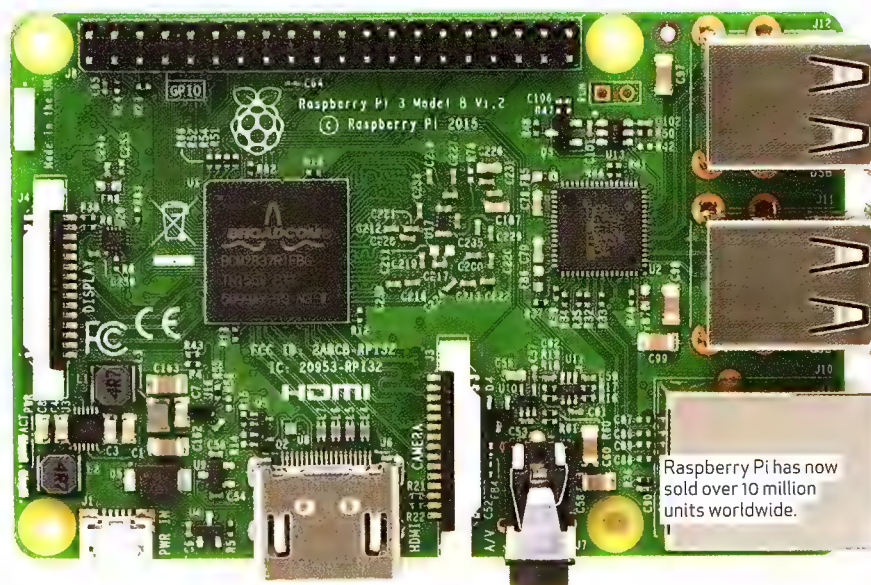
Android SDK Platform Tools (that we've recently covered in-depth) for the Intel Edison. Bottom-line, make sure you follow the appropriate install instructions for your particular board (tinypurl.com/zsdxfsfh).

ADDITIONS AND TAKEAWAYS

Even supporting devices with 512MB of RAM on-board, Android Things is notable for what it includes – as well as what it leaves out.

Arguably the most important addition is the Peripheral I/O API. It provides the code-hooks to connect the development kit board to external devices using standard protocols. According to Google, protocols supported include GPIO (general-purpose input/output), PWM (pulse-width modulation), I2C (inter-integrated circuit), SPI (serial peripheral interface) and UART (universal asynchronous receiver/transmitter). This enables Android Things boards to hook up to a range of display devices and sensors, such as ultrasonic, temperature/humidity, magnetometers and OLED/LCD panels.

Then there's TensorFlow ([tensorflow.org](https://www.tensorflow.org)), Google's machine-learning library that allows you



Raspberry Pi has now sold over 10 million units worldwide.

to build in analytics and in-depth mathematical operations into your IoT project.

But as Google giveth, so it also taketh away — a decent swag of content-provider APIs have disappeared, including DownloadManager, Settings, Telephony and MediaStore.

Android Things still supports graphical user interfaces (GUIs) and the standard UI Toolkit remains, but not the system status bar or navigation buttons. The good news is displays are optional, in support of 'headless' IoT designs (tinyurl.com/hqmqrls).

More broadly, Google has also axed some Google services in Android Things. Services surviving include screencasting and using Android devices as remote controls (Cast), Google Drive (Drive), as well as fitness (Fit), Location, Nearby and Places. Services that didn't make the cut include AndroidPay, AdMob, Maps, Play Games, Search and Sign-In. You can read the list on the Google Developers page (tinyurl.com/hqmqrls).

DEVELOPING HARDWARE

What will likely be different for many

Android developers is making hardware (something we've been doing for a few years now in our Arduino Masterclass series).

Google even offers a 'Hardware 101' guide to get users started (tinyurl.com/ztffurs4); however, in our view, it doesn't go near far enough and its concept of 'resistor strength' isn't one you'll find in too many electronics textbooks.

While the current Android Things development hardware support is definitely a step up in performance from Arduino, the electronics principles involved in connecting the outside analog world to a CPU-controlled board remain the same. Breadboards, interconnecting wires, components all mean you'll need at least a moderate level of electrical engineering knowledge before trying to develop reliable IoT systems.

While C/C++ has given way to Java as the primary coding language, it hasn't gone entirely. Thanks to the newly added support for Android Native Development Kit (NDK), developers will be able to use their own C/C++ code to communicate with external devices via I/O ports available on Android

Thing-ready boards. Called 'Native PIO' (tinyurl.com/hjzohf9), your C/C++ code can handle GPIO, PWM, I2C, SPI or UART devices and data transfer.

HARDWARE MISSING

But if you're coming from an Arduino background, the one thing you'll likely miss is 'analog inputs'. On most Arduino boards, these inputs allow you to provide direct and continuous (analog) voltages to the microcontroller through a built-in 'analog to digital converter' (ADC). For example, say you want to make a simple light sensor — on an Arduino, you could use an LDR (light-dependent resistor) connected between an analog input and ground, with that input set to use its internal pull-up resistor to create a voltage divider whose output varies with light intensity. You then read the analog input for its digital value, thanks to the internal ADC.

None of the four boards so far supported by Android Things has an on-board ADC — that means you must supply your sensor data either in digital form or use your own ADC, which can be problematic. Online electronics retailer SparkFun has a 'block' expansion board for the Edison that adds a 12-bit ADC for US\$10 (tinyurl.com/hqmb449).

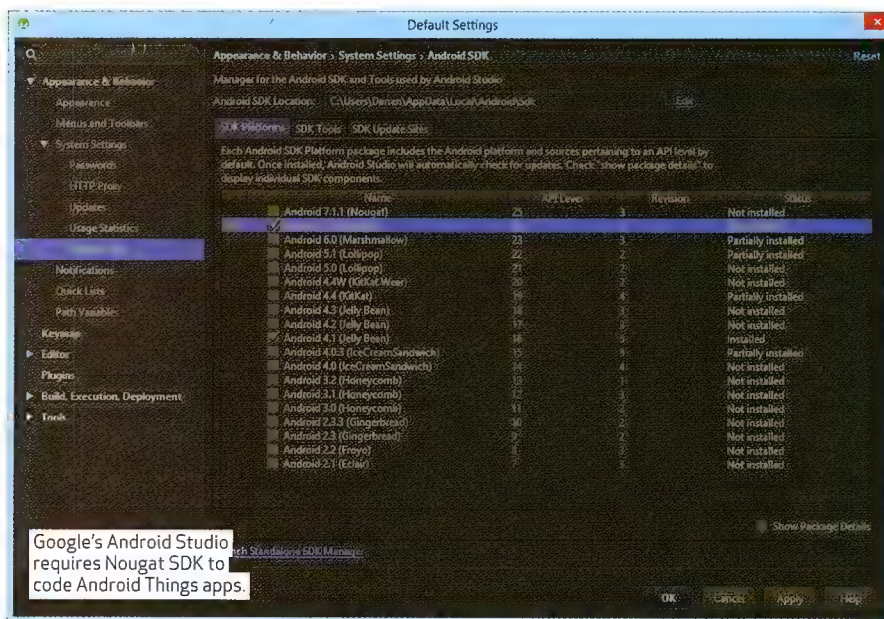
OTA UPDATES

One of the features Google is keen on with Android Things is the ability to push updates over the air (OTA) to an IoT device, not just Google's but your own app updates as well.

However, some online already seem a bit wary, asking how long will these Google OTA updates continue. We think it's a fair-enough question, as the Android ecosystem has a trail of orphaned devices stuck on older versions of Android (tinyurl.com/m7zm5cu).

How long should Google support these current development kits? We'd argue it needs to be more than the two years or so smartphones and tablets seem to currently get. Replacing an orphaned smartphone is one thing, but ditching an IoT-connected appliance or smart-home feature because someone decides 'your hardware is out of date' isn't likely to go down well. Moreover, industrial IoT device users will rightly expect long-term support as well.

Google's recent moves to provide direct OTA support, rather than relying on telcos for OS updates, paves the way for a decent solution. An IoT platform that can remotely update its core OS features, including security, without relying on the IoT app developer to do the leg work has decent potential.



Supported APIs	Unavailable APIs
Cast	AdMob
Drive	Android Pay
Firebase Analytics	Firebase App Indexing
Firebase Cloud Messaging (FCM)	Firebase Authentication
Firebase Crash Reporting	Firebase Dynamic Links
Firebase Realtime Database	Firebase Invites
Firebase Remote Config	Firebase Notifications
Firebase Storage	Maps
Fit	Play Games
Instance ID	Search
Location	Sign-In
Nearby	
Places	
Mobile Vision	

Not all of Android's services made it into Android Things, here's the list.

Apps

Java API Framework

Google Services

Things Support Library

Native C/C++ Libraries

Hardware Abstraction Layer (HAL)

The Android Things framework showing abstraction layers of code.

Linux Kernel

SLEDGEHAMMERS AND BLACKOUTS

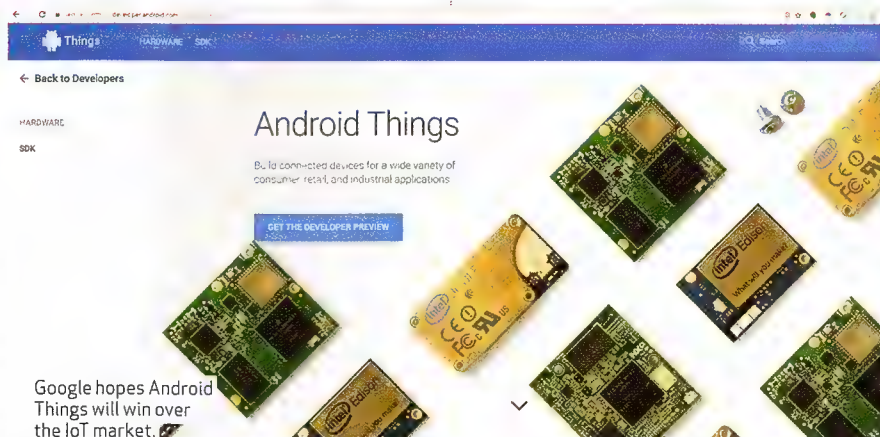
Overall, Android Things tries to address a number of issues that everyone laments regarding IoT, from lack of data standards to security fears. Still, it may well be early days for the OS, but I have concerns for Android Things and the broader IoT market.

One notable barrier to Android Things at the moment is the hardware requirements — the apparent need for at least 512MB of RAM essentially makes this a computer-grade operating system requiring a computer-grade CPU. By that, read 'ARM Cortex A-series' SoCs (system-on-a-chip) that power just about every smartphone and tablet.

The problem with that is that many IoT applications just don't need that amount of CPU horsepower — in many cases, it'd be a bit like taking your Rolls Royce Phantom down to the local takeaway to grab your Friday-night fish and chips.

At time of writing, the 'microcontroller' class of processors, including from 8-bit Arduino-grade devices up to 300MHz low-power high-performance 32-bit Cortex M-series cores, appear to be ignored by Android Things. We hope this soon changes.

Another issue is power consumption. The current hardware development kits supported, such as the Raspberry Pi 3, are indeed popular, but they can also chew through considerably more power than the vast majority of microcontrollers. For example, according to the Raspberry Pi Foundation, the Raspberry Pi 3 requires around 400mA of current minimum to operate (tinyurl.com/ln07myc). By contrast, ST Microelectronics' 32-bit STM32F405



microcontrollers running at 168MHz can operate on one-tenth of that current (tinyurl.com/jlgul75, PDF, page 8). Now microcontrollers generally require C/C++ coding and don't have the RAM to hold an OS, but then, not every IoT device needs an OS.

For now, it seems the fundamental issue is that higher-performance boards are needed to give IoT security some muscle; however, that muscle will often result in an IoT device that otherwise performs the equivalent of cracking a walnut with a sledgehammer.

More broadly, this approach to IoT design is a growing issue we reckon the tech industry will have to address.

There's an old saying that, when all you have is a hammer, everything looks like a nail. I like the Raspberry Pi as much as the next geek, but if the major tech players want to encourage smart IoT development, maybe we need to get past building connected doorbells using a Raspberry Pi simply because that's the hardware everyone is familiar with.

Here's one reason why — power generation is a hot topic in Australia right now, given issues in South Australia and calls to reduce power consumption during this past summer's heatwaves in NSW, Victoria and Queensland. A recent 2016 report by the International Energy Agency (IEA) stated that, while IoT could be an 'enabler of applications' that lead to reduced power demands, it concluded that 'the expected future contribution of mains-connected IoT devices to the worldwide annual energy consumption is significant' (tinyurl.com/jgft8ww, PDF, page 7). By all means, encourage IoT development — but we need equal focus on power-efficient design and that has to include microcontrollers.

Android Things clearly aims to provide a general-purpose platform for anyone with Java coding skills to create connected and secure IoT devices. But for now at least, we're not convinced it's the most power-efficient platform for every IoT project. ■

Capture stereo sound with Arduino Nano

How do you capture two audio channels with just one analog-to-digital converter? Darren Yates explains how with this new project using the popular Arduino Nano.

If there is one thing Arduino boards have never really been designed to do, it's record digital audio. So over the last couple of years, we've taken, first, an Arduino Uno and then an Arduino Mega and done exactly that. But those designs could only capture one audio channel. This month, we fix that by turning the tiny Arduino Nano into a stereo digital audio recorder.

ONE GETS YOU TWO?

Even if you don't know anything about the original 8-bit Arduino boards, the key things to remember are: a) they're not very fast; b) they don't have much on-board storage; and c) they only have one analog-to-digital converter (ADC).

We don't have space here for a full rundown, but just quickly, an ADC turns analog voltage (of the type you get from audio) into digital values. However, you usually have one ADC per audio channel, so if you want to record stereo, you'd have two ADCs. Problem is, the Arduino Nano only has the one.

CHANNEL MULTIPLEXING

We could use two Nano boards and somehow synchronise them together, but the solution we're using here needs just the one board. The trick

is provided by the Arduino Nano itself and it's the built-in analog input multiplexer. A multiplexer is a bit like an electronic set of traffic lights that switches between different lanes onto a highway. Traffic can flow from each lane when the light for that lane goes green. The Nano has eight analog inputs that can each be switched to the ADC – and we take advantage of that to create our stereo sound sample.

TIMER INTERRUPTS

The key to any digital audio recorder is sampling the audio at regular, fixed time periods. The Nano gives us these fixed time periods through its on-board 'timers'. We set up a timer to trigger an 'interrupt' every 41.66 microseconds – this interrupt is an electronic red flag that diverts the current code operation to an 'interrupt service routine' (ISR) that we specify – code that grabs the audio samples.

We do that by setting the analog multiplexer first to input A3, grabbing the left-channel sample and temporarily storing it, then switch the multiplexer to input A4 and grab the right-channel sample. During normal operation, the Nano takes these samples and writes them to the microSD card reader module we've also added. The '41.66 microseconds' is important – it gives us a sample

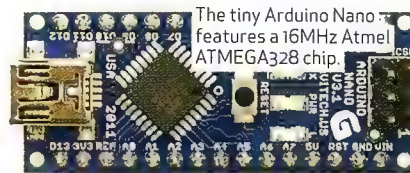
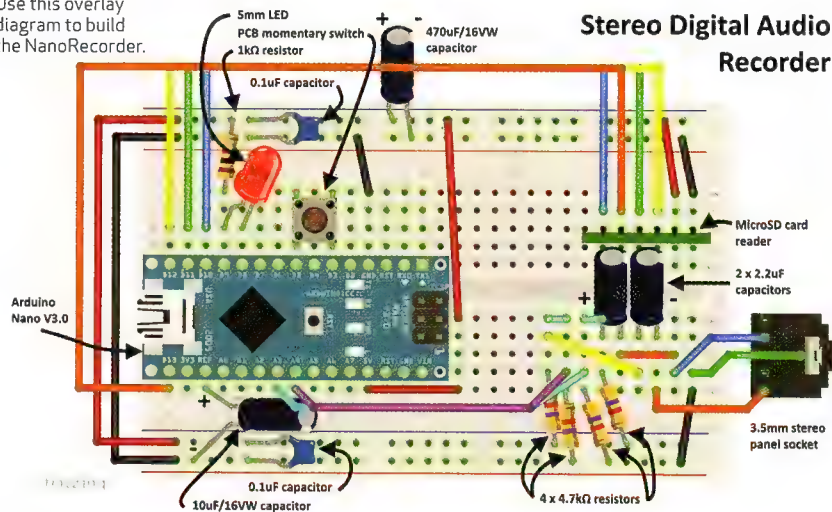
frequency of 24kHz, which is a valid (although lesser-known) WAV-format rate. The reason for using 24kHz is two-fold. First, the Arduino simply can't grab stereo samples any faster than that – if we try, we start dropping samples all over the place. Second, with only 2KB of RAM, we've only space for 1KB of audio buffer and the faster the sample rate, the less recording time that buffer holds.

Before recording begins, we create a WAV file header that outlines to media players how the file works. We then store the samples and update the header at the end.

WHY A BUFFER?

If you're wondering why we don't just save the samples straight to the microSD card, we would dearly love to – but the problem is that these cards have what's called a 'latency' or delay period. Writing data to a flash card requires the card to organise its storage, and each time you write, there's a small delay while it finds the appropriate spot in that storage. Unfortunately, the delay can vary from as little as 10 microseconds up to half a second. In professional audio recorders, sufficient RAM is included to cover this delay, acting as temporary

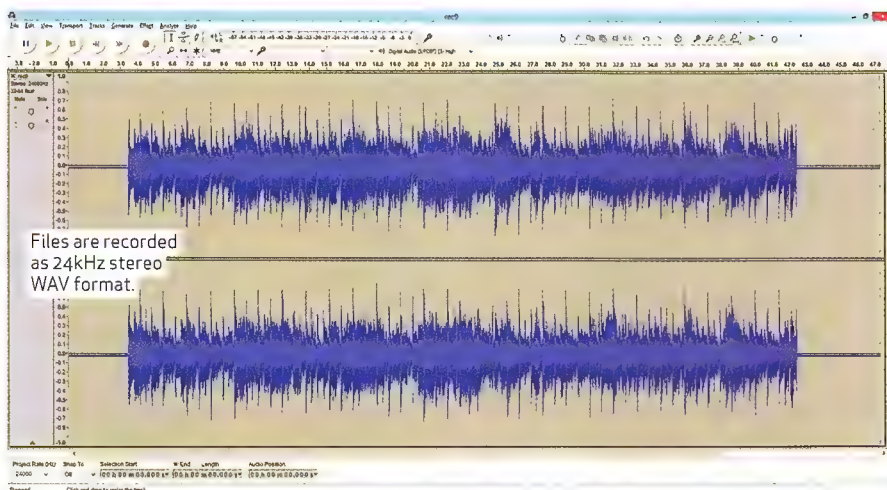
Use this overlay diagram to build the NanoRecorder.



The tiny Arduino Nano features a 16MHz Atmel ATMEGA328P chip.



You'll find this microSD card reader on eBay for a couple of dollars.



subfolder into the same of your Arduino IDE, load up the nanoRec_v1.ino source code and flash it to the Arduino Nano board. Get the Arduino IDE from arduino.cc/downloads.

To operate the recorder, first install your FAT32-formatted card into the card module and power up. If you don't, the LED will flash indefinitely, requiring a reboot of the Nano. Plug your line-level audio source into the 3.5mm stereo socket, press the button and the LED will flash four times to indicate recording as begun. To stop recording, press the button again – this will initiate a fast 10-cycle LED flash. Take your microSD card, load it into your PC, fire up Windows Media Player, select the file (WMP happily plays 24kHz WAV files) and enjoy.

SOUND QUALITY?

Despite the single ADC, you should hear excellent channel separation, made better by the small delay between left- and right-channel samples as the multiplexer switches between the two. We've measured the distortion at approximately 0.4% at 1kHz full-scale (-0.5dBFS) and the signal-to-noise ratio (SNR) is around 40dB. With a 24kHz sample rate, Harry Nyquist says that gives us a frequency response to 12kHz. Given this is only 8-bit audio, those figures are about as good as you can get. The 10uF capacitor on the Nano's Vref pin filters the reference voltage to the ADC, which plays a big role in keeping the SNR and distortion tight.

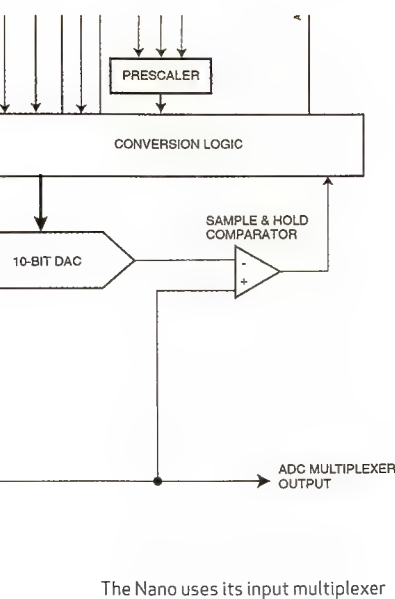
This isn't the recorder to use for classic music and it's not CD-quality, but for recording voice, rock, pop or any similarly reduced-dynamic-range audio input, you might be surprised at how good this little recorder sounds. ■

storage. But with only 2KB on the Nano, there's only so much we can do. What's more, for this to work, you have to use a SanDisk Ultra microSD card. We've tested a number of cards and the SanDisk Ultra had the lowest overall latency – you can pick up an 8GB card for around \$7.

The buffer provides somewhere to store samples every 41.6 microseconds and with 1KB of storage, we can store 512 samples from both channels. At a sample rate of 24kHz, 512 samples takes just 21.3 milliseconds. The SanDisk Ultra card we purchased has a latency of around 15 milliseconds, worst-case. Since the buffer can store more samples than the time it takes the SanDisk card to write them, we shouldn't lose any samples. And from our testing, we don't. This isn't to say other microSD cards won't work – but it comes down to their latency times, not necessarily write speeds.

BUILDING THE PROJECT

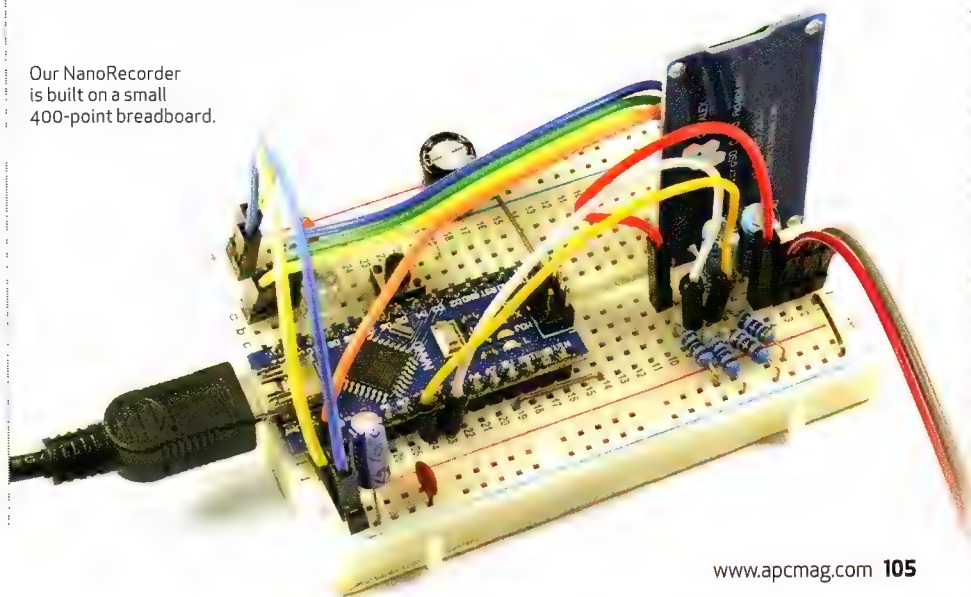
We've built the 'NanoRecorder' on a small 400-point breadboard from



The Nano uses its input multiplexer to capture two audio channels.

parts purchased on eBay – use the overlay diagram as your guide. The resistors bias the ADC input to half the supply rail (2.5VDC) to maximise signal input range before any clipping distortion occurs. You can grab the source code from www.apcmag.com/magstuff, unzip it, copy the contents of the libraries

Our NanoRecorder is built on a small 400-point breadboard.



The power of strings and dictionaries

Learn how to use Python's powerful functions for manipulating and storing strings. Darren Yates explains.

It's a common fact that, for various reasons, not everyone loves numbers (yes, strange, I know) but numbers on their own aren't nearly as interesting as the functions you can perform with them. For example, we all learned to add, subtract, multiply and divide numbers in school – but functions with letters or characters? We write them and spell them, but that's about it. Yet when it comes to coding, letters aren't just for displaying messages on the screen – there's a swag of functions you can perform with these characters, especially when joined together to form 'strings'. This month, we'll look at some powerful Python string-manipulation functions you should have in your coding toolbox, plus delve into the advanced data structure of dictionaries.

WRITE A LETTER

Let's start with the obvious – collections of letters grouped together in a meaningful fashion are called 'words', words grouped likewise, we call 'sentences'. Yes, welcome to English 101. But in coding, collections of alphanumeric characters are also called 'strings'. What's more, you can access each individual character in a string by its position in that string. For example:

```
title = 'APC magazine'
```

...describes the characters stored as a string in a variable called 'title'. Among the many things we can do with this is find the number of characters in or 'length' of the string. Run the code in the IDLE Shell:

```
print (len(title))
```

...and you'll get the answer '12'. You can also address the characters of a string individually:

```
print (title[0])
```

...returns 'A'. The method is similar to accessing elements of an array – you use the square brackets to indicate the character position you're

after. Just remember, string indexing starts at zero.

COUNTING LETTERS

Grab this month's source code pack from our website (apcmag.com/magstuff), launch the IDLE editor (part of Python 3.6 from www.python.org) and open 'countletters.py'. This code counts up the frequency of letters in a string. We start by assigning the string-of-interest to the variable 'newString' and use the function

'String.lower()' to return the lower-case version and store it back in the 'newString' variable. Next, we create another string variable, this time with all the lower-case letters of the alphabet and store them in variable 'alphabet'. That's followed by what may appear to be an odd-looking line, but it's really just a quick way of initialising a list called 'charCount' with 26 cells, all having the value '0', the '0' character acting as a repetition operator. We'll use this shortly to store

```
# Frequency of letters in a string - version 1
# 18-February-2017 Darren Yates

newString = 'The quick brown fox jumps over the lazy dog'
newString = newString.lower()
alphabet = 'abcdefghijklmnopqrstuvwxyz'
charCount = [0] * 26

for letter in newString:
    if (letter in alphabet):
        charCount[ord(letter)-97] += 1

for letter in alphabet:
    print(letter, charCount[ord(letter)-97])
```

Using the 'ord()' function to create the index to store letter counts.

```
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> CPUClocks = {"AMD Ryzen 7 1700": 3.0, "AMD Ryzen 7 1700X": 3.4, "AMD Ryzen 7 1800X": 3.6}
>>> print(CPUClocks.items())
dict_items([('AMD Ryzen 7 1700', 3.0), ('AMD Ryzen 7 1700X', 3.4), ('AMD Ryzen 7 1800X', 3.6)])
>>> print(CPUClocks.get("AMD Ryzen 7 1700X"))
3.4
>>> print(CPUClocks.keys())
dict_keys(['AMD Ryzen 7 1700', 'AMD Ryzen 7 1700X', 'AMD Ryzen 7 1800X'])
>>> print(CPUClocks.values())
dict_values([3.0, 3.4, 3.6])
>>>
```

Another example of dictionary functions using something closer to home.

```
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_9\countchars.py =====
Counter({'o': 4, 'e': 3, 't': 2, 'h': 2, 'u': 2, 'r': 2, 'q': 1, 'i': 1, 'c': 1, 'k': 1, 'b': 1, 'w': 1, 'n': 1, 'f': 1, 'x': 1, 'j': 1, 'm': 1, 'p': 1, 's': 1, 'v': 1, 'l': 1, 'a': 1, 'z': 1, 'y': 1, 'd': 1, 'g': 1})
>>>
```

Using the Counter function returns character counts as a dictionary.


```
Python 3.6.0 Shell
>>>
===== RESTART: C:\Users\Darren\Python
Code\Python_EP_9\countletters.py
=====
a 1
b 1
c 1
d 1
e 3
f 1
g 1
h 2
i 1
j 1
k 1
l 1
m 1
n 1
o 4
p 1
q 1
r 2
s 1
t 2
u 2
v 1
w 1
x 1
y 1
z 1
>>>
```

First version of our character-counting code returns a list of results.

the count of each letter in the 'newString' variable.

ITERATING OVER A STRING

For-loops are fantastic things – and they're brilliant for looping through strings. Commonly, for-loops are used to loop or 'iterate' over a numeric range. However, here, we're iterating over the objects themselves. We start by coding the line:

```
for letter in newString:
```

In this case, 'letter' is the creation or 'instantiation' of a new variable called 'letter' – we're creating it and using it at the same time. In this case, Python knows from the variable type 'newString' is that we want it to fetch each character in that variable in turn and put it in the variable 'letter'. You could also read it as 'for each letter in the newString variable'.

That's followed by what we want Python to do with each character. Here, we use an if-clause and the 'in' operator again, this time to see if the character is found in the 'alphabet' string (you can use the 'in' operator with if-clauses and for-loops). If the character is found in the alphabet variable, we then find its ASCII value using the 'ord()' function, subtract 97 from it, make the result the index for the charCount list and increment the value stored at that index.

Why? The ASCII (American Standard Code for Information Interchange) code assigns a numeric code to a set of standard characters. There are 255 different codes, including codes for upper- and lowercase letters, as well as special

```
Python 3.6.0 Shell
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10)
[MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> title = 'APC magazine'
>>> print (len(title))
12
>>> print (title[0])
A
>>>
```

The 'len()' function returns the size of a string.

```
countchars.py - C:\Users\Darren\Python Code\Python_EP_9\countchars.py (3.6.0)
# Frequency of letters in a string - version 2
# 18-February-2017 Darren Yates

from collections import Counter

newString = 'The quick brown fox jumps over the lazy dog'
newString = newString.lower()
alphabet = 'abcdefghijklmnopqrstuvwxyz'

charCount = Counter(letter
    for letter in newString
    if letter in alphabet)

print (charCount)
```

Using the 'Counter' function creates a more elegant code solution.

"Letters aren't just for displaying messages on the screen — there's a swag of functions you can perform."

characters. For example, 'a' is 97, 'b' is 98 and so on. Python's ord() function returns the ASCII numeric code for any character. However, by subtracting 97 from the ord() function result, we're re-aligning the value so that it matches one of the 26 values in the charCount list.

Here's an example – the first letter in the example 'newString' is 'T', which becomes 't' after the lower() function. As we go through the initial for-loop for the first time, the if-clause checks to see if 't' is in the 'alphabet' variable string, which it is. The function ord('t') returns the value '116', we then subtract 97 from it and get 19. This becomes the index of the charCount list and we add one to the 19th value of charCount, keeping score of the number of 't's found in 'newString'.

Another example, say the first letter was 'a', ord('a') would return 97. Subtract 97 from 97 and you get zero, so the letter 'a' corresponds to the first element of the charCount list (list indexes start at zero).

The second for-loop in the code iterates over the 'alphabet' string, printing out each letter and its

corresponding frequency recorded from the newString variable.

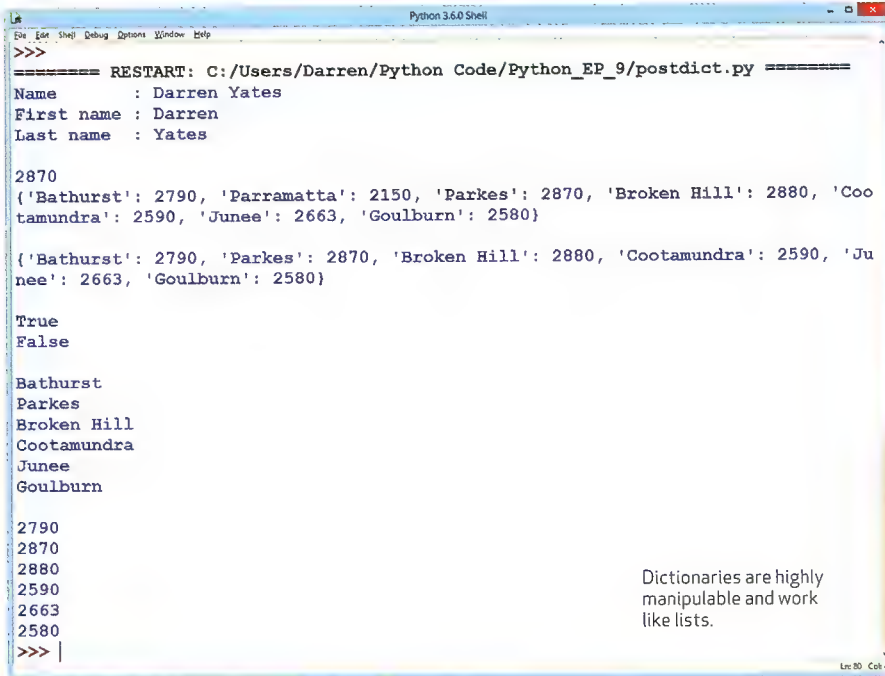
A MORE EFFICIENT VERSION

Now I do tend carry on a bit in this masterclass about how there's always more than one way to code a solution to something – and this is a perfect example. Run the 'countletters.py' code we just spoke about and it works. However, it does require you to understand how the ASCII code works, which makes it pretty kludgy.

Load up 'countchars.py' and you'll find a more elegant solution. We start by importing the 'Counter' subclass from Python's 'collections' module. In this version of our character-counting app, the 'newString' and 'alphabet' strings are the same as before, but the charCount variable, this time, contains the results of the Counter function:

```
charCount = Counter(letter
    for letter in newString
    if letter in alphabet)
```

What's happening here is that we're asking Python to use the Counter



```

>>>
===== RESTART: C:/Users/Darren/Python Code/Python_EP_9/postdict.py =====
Name      : Darren Yates
First name : Darren
Last name  : Yates

2870
{'Bathurst': 2790, 'Parramatta': 2150, 'Parkes': 2870, 'Broken Hill': 2880, 'Cootamundra': 2590, 'Junee': 2663, 'Goulburn': 2580}

{'Bathurst': 2790, 'Parkes': 2870, 'Broken Hill': 2880, 'Cootamundra': 2590, 'Junee': 2663, 'Goulburn': 2580}

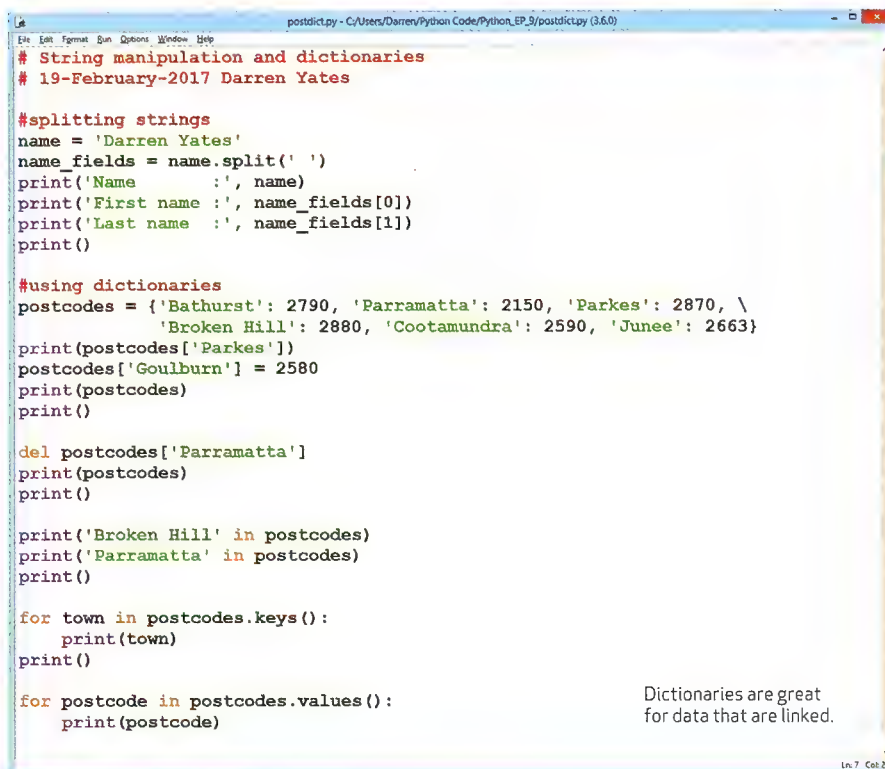
True
False

Bathurst
Parkes
Broken Hill
Cootamundra
Junee
Goulburn

2790
2870
2880
2590
2663
2580
>>>

```

Dictionaries are highly manipulable and work like lists.



```

# String manipulation and dictionaries
# 19-February-2017 Darren Yates

#splitting strings
name = 'Darren Yates'
name_fields = name.split(' ')
print('Name      :', name)
print('First name :', name_fields[0])
print('Last name  :', name_fields[1])
print()

#using dictionaries
postcodes = {'Bathurst': 2790, 'Parramatta': 2150, 'Parkes': 2870, \
             'Broken Hill': 2880, 'Cootamundra': 2590, 'Junee': 2663}
print(postcodes['Parkes'])
postcodes['Goulburn'] = 2580
print(postcodes)
print()

del postcodes['Parramatta']
print(postcodes)
print()

print('Broken Hill' in postcodes)
print('Parramatta' in postcodes)
print()

for town in postcodes.keys():
    print(town)
print()

for postcode in postcodes.values():
    print(postcode)

```

Dictionaries are great for data that are linked.

function to count up each 'letter' that appears in 'newString' if that 'letter' also appears in the 'alphabet' string. The beauty of this method is you no longer need to know anything about ASCII codes and Python takes care of everything, thanks to the Counter function.

One of Python's strength is the mass of modules available that add in functions for seemingly almost anything you can imagine.

DICTIONARIES

The only real difference between the two versions is that, instead of

finishing with the list of values we had before, the charCount variable in this version now references a 'dictionary'. Dictionaries are really useful data structures that work, more or less, like a real dictionary.

Look up any dictionary and you see a list of words, each followed by a definition that explains the word. In the world of Python, dictionaries work in a similar way, except that the 'words' are called 'keys' and the definitions are 'values'. So putting it more succinctly, a dictionary is a list of key-value pairs.

Run the 'countchars.py' code and, this time, you'll see the output starts with 'Counter', but is followed by a list of key-value pairs inside a set of curly-brackets {}.

When you look up a dictionary, you first search for the word, then read the definition. To get the value of a particular 'key' in a Python dictionary, you simply call the dictionary and use the 'key' like an index for a string or list.

For example, we can find out the total count of the letter 'o' by using:

```
print(charCount['o'])
```

And that gives us '4'. If we replace 'o' with 'e', we get the result '3'. We'll come back to dictionaries in a moment.

STRING FUNCTIONS

The chances are pretty good that, whenever you code apps, you'll need to provide some form of text output back to the user. However, you're just as likely to have to test string responses from the user as well.

USER-INPUT VALIDATION

This is often called 'user input validation' and we'll look at a basic example. Say you're writing an app that asks the user to enter in their postcode. Postcodes in Australia are four-digit numbers, but what if the user enters in an alphanumeric postcode — how do you handle it?

Open up the 'postcodes.py' code. Here, we begin by using the standard 'input' function, prompting the user to enter a four-digit postcode and storing the result in the 'userInput' variable.

Next, we enter a while-loop with the condition that if ever the value of 'userInput' does not contain numeric-only characters and is not exactly four digits in length (that's what the 'isdigit()' and 'len()' methods check), print an error message and get the user to try again. Once the user gets it right, we print the result.

The isdigit() method is just one of a number available for testing the contents of strings. The others are 'isalpha()' to check for all alphabet characters, 'isupper()' for uppercase, 'islower()' for lowercase and 'isalnum()' for alphanumeric. You can use this last one, for example, to check for extended character codes like backslashes '\' or colons ':' that might indicate someone trying to hack your code.

SLICE AND DICE

You'll also find occasions where you need to split the user's input into various fields, for example, when entering their name. Strings allow


```

userinput.py - C:/Users/Darren/Python Code/Python_EP_9/userinput.py (3.6.0)
File Edit Format Run Options Window Help
# Simple user-input validation
# 19-February-2017 Darren Yates

userInput = input('Enter in a four-digit postcode:')
while not (userInput.isdigit() and len(userInput) == 4):
    print('Sorry, no good - please try again.')
    userInput = input('Enter in a four-digit postcode:')
print('The postcode you entered was', userInput)

```

String testing functions make testing user input much simpler.

Ln: 1 Col: 30

```

Python 3.6.0 Shell
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:/Users/Darren/Python Code/Python_EP_9/userinput.py =====
Enter in a four-digit postcode:286F
Sorry, no good - please try again.
Enter in a four-digit postcode:23411
Sorry, no good - please try again.
Enter in a four-digit postcode:2860
The postcode you entered was 2860
>>>

```

A while-loop allows your code to wait until the user gets it right.

Ln: 11 Col: 4

you to do that using the `split()` function. Here's a simple example:

```

name = 'Darren Yates'
name_fields = name.split(' ')
print('First name:', name_fields[0])
print('Last name:', name_fields[1])

```

The `split()` function splits the words of the 'name' string using the space character as the delimiter or separator and auto-assigns the individual words into a list we've called 'name_fields'. We then use indexes to grab the individual fields and print them to screen.

USING DICTIONARIES

Dictionaries are great for when you want to store data that is attached to an entity as a distinct pair – the key-value pairs we were on about earlier. It could be anything from pizza prices to town postcodes. To create a predefined or 'literal' dictionary, you enter your data as pairs with a colon ':' separating the key and value of each pair, then separating the pairs with commas, like this:

```

postcodes = {'Bathurst': 2790, 'Parramatta': 2150, 'Parkes': 2870, 'Broken Hill': 2880, 'Cootamundra': 2590, 'Junee': 2663}

```

Then it's just a case of calling the 'postcodes' dictionary with an appropriate key:

```
print (postcodes['Parkes'])
```

...should give back '2870', which in this case is an integer because that's how it was entered into the dictionary. The rule is you can use just about anything as a value, but the keys must be basic data or 'immutable' types – that means integers and strings mostly – and strings are case-sensitive, so 'Parkes' is different to 'parkes'.

Dictionaries are also like lists in that you can add and delete key-value pairs. However, unlike lists, you don't need to 'append'. You just use your desired key as the index and assign it the value:

```
postcodes['Goulburn'] = 2580
```

You can also use this method to change a key-value pair – just use the same key, assign it a new value and it'll essentially overwrite the old one.

To delete a key-value pair from a dictionary, you use the 'del' method and the key of the dictionary entry you want to ditch:

```
del postcodes['Parramatta']
```

If the key exists, the pair will be removed and the rest will shuffle up into place, just like a list. If it doesn't exist, the statement will throw a 'KeyError' exception, which you can handle using a try-except clause. You can even test for keys in code using the 'in' operator, for example:

```
town_postcode = "Broken Hill" in postcodes
```

...returns the Boolean value 'true' to 'town_postcode' because the postcodes dictionary does have a key called 'Broken Hill'. However:

```
town_postcode = "Parramatta" in postcodes
```

...returns 'false' because we just deleted it from the dictionary and it no longer exists.

SIMPLE DICTIONARY FUNCTIONS

There's also a bunch of methods available for manipulating dictionaries – two of the most common are the 'keys' and 'items' methods. To get a list of the keys in a dictionary, you can just iterate over the dictionary keys using:

```

for town in postcodes.keys():
    print(town)

```

And to get a list of values in a dictionary, you do the same but with values instead:

```

for postcode in postcodes.values():
    print(postcode)

```

Load up the 'postdict.py' source code and you'll find these examples, ready to run. If it helps, think of dictionaries as customised lists where indexes don't have to be numeric, a bit like a simple database.

GIVE IT A GO

The great thing about Python is its uncluttered nature, which helps make it one of the easiest languages to pick up, even if you've never coded before. That's why it's used in everything from games and Linux scripting to websites and data science.

We'll be back again next month. See you then. ■

downtime

PHOTO: UBISOFT GAMES. EDITED BY CARMEN SUTHERLAND

And I thought Vikings and Samurai only ever met in my wildest dreams...!

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RECOMMENDS

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For Honor

Ubisoft delivers a calm, considered and artful hack and slasher.

Screenshots suggest *For Honor* is yet another stock standard grizzly action game, but it's a bit smarter than your average hack'n'slasher. Indeed, while there is much hacking and slashing to be had in Ubisoft's new multiplayer-focused title, the game relies heavily on tactical hand-to-hand combat, demanding both precision and close attention to the movements and intentions of your opponent.

While *For Honor* is a multiplayer-focused game, there is a single-player campaign which does a decent job of both driving home the combat's intricacies while spinning a batshit crazy but nonetheless enjoyable yarn. The enemies you'll face come in two general categories, including the minions you can smite without a second thought, through to the tougher enemies you'll need to engage in more tense combat. The latter is where the meat of the game's

novelty lies, and it's why it feels more like a fighting game — think *Dark Souls* crossed with *SoulCalibur* — than it does anything else. Oh, and as for the “batshit crazy” angle, you can play as a Knight, a Viking or a Samurai in this game. Which is stupid if history is your bag, but excellent if variety is more important to you.

Once you've finished the single-player mode in about 6–8 hours, the multiplayer is where the rest of your time will be spent. Dominion, Deathmatch and Duels are the main modes, and all have their strengths: the first is a point capture mode with four human players on each team, augmented by the aforementioned minions. Deathmatch is what that name implies, while Duels are, arguably, the most fun you'll have in multiplayer. The 1v1 duels are among the most stripped back and intense scraps I've had in a multiplayer game since *Dark Souls*, sharpening the game's

combat into fraught psychological warfare between you and NoScopeBro204 from Warrnambool (yes, *For Honor* has local servers).

There's a faction-based meta game draped over these PvP modes, but the game is still too young to judge whether it'll prove engrossing or superfluous, as the success of this game will depend on how dedicated its userbase is, and how well Ubisoft supports it. For now, it's easy to get a game and *For Honor* is a joy to play, but whether or not the same could be said in six months' time or a year is yet to be seen. Assuming *For Honor* builds a passionate userbase, it's a unique hobby game with a lot of potential. ■ Shaun Prescott

Verdict

A challenging and clever multiplayer-focused game that will hopefully shine, providing the fans stick around.



Some of the tougher enemies require more tactical approaches to eliminating them.

It may not boast the most detailed textures, but this is an astonishingly pretty game at times.

apc
HOT PRODUCT

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This game has room to breathe.

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The Legend of Zelda: Breath of the Wild

Nintendo's largest game world feels like a breath of fresh air.

The subterranean shrines that pepper Nintendo's largest ever game world – serving as tutorials, pacing devices, fast-travel points, signposts, landmarks and puzzles – are by no means the sole expression of *Breath Of The Wild's* desire to tax the grey matter.

See those mountains on the horizon? You can go to them, yes, but it's not a simple matter of setting a map marker and following a GPS route. Heading to a mountain-top shrine, you find yourself divided from your destination by a large ravine. Do you cross it using the bridge on the horizon? Do you paraglide across? Could a cliffside tree be chopped down and serve as a bridge? Whichever route you choose, chances are you'll get dragged farther off course along the way. There might be a bandit

camp to clear out, a wild horse to break, a peak to scale, a traveller might hint at a nearby treasure, a bard may sing of a secret shrine that only appears under certain conditions. The next morning, you'll saddle up, head off and, with any luck, remember what it is you came here for. This is a game where you always have somewhere to go, and sometimes even make it there.

We're not quite sure how Nintendo has done it. A land this full of puzzles, secrets and distractions should feel contrived. Yet this colossal world has been given room to breathe, despite the volume of things in it. And for all its fantasy, it feels natural, albeit for the fact that cooking up monster parts yields an elixir that quietyens your footsteps.

At some point, you'll get around to taking on the

main quest. Calamity Ganon has been sealed away for 100 years, but his power is growing; he's taken control of the four Divine Beasts, hulking mechanical constructs that, corrupted, are causing merry hell in the regions they once protected. At the urging of the tribal elders, Link must free the Beasts of their corruption and return them to their rightful owners so they can assist him in defeating Calamity Ganon.

Nintendo has spoken of hitting the reset button on a series that had become too rigidly adherent to a decades-old dripfeed-style template. By the time you've completed four shrines in the Great Plateau starting area and used your reward, the paraglider, you'll already have every power you need to go anywhere and do anything. Combat can be a little

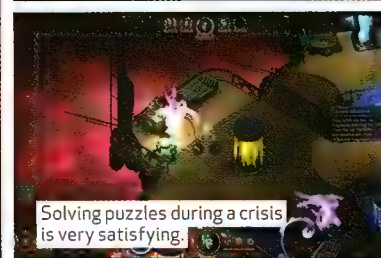
unpredictable; the timing window for a dodge is either a tiny opening or a generous chasm. You'll be hit by things you swore you'd dodged, and the camera position may interpret your backwards jump as a sideways one. But if the melee stuff is proving a chore, just chuck a bomb in there or pick them off with arrows.

Not since *Ocarina Of Time* have we set foot in a world that seems so vast, magical and intriguing. 19 years on, it's still held up as one of gaming's best-loved series. Now it may have to settle for second place. ■

Verdict

Plenty of games promise to let us go anywhere and do anything. This one actually delivers.





PC, PS4, X0 | \$89.95 | TORMENT.INXILE-ENTERTAINMENT.COM

Torment: Tides of Numenera

Start a new life in the Ninth World.

The original *Torment* was highly regarded and its influence is felt throughout the RPG genre, from *Pillars of Eternity's* soul-reading to the warped denizens of *Fallen London*. Yet it's never, until now, had a proper follow-up.

Torment: Tides of Numenera is that successor. inXile has recaptured much of what made the original game special. This is a free-roaming, dialogue-heavy isometric RPG that places thought resolutely before action. Although combat features, the entire campaign can be played without participating in violence yourself.

The Planescape setting is gone, swapped for the Ninth World – the far-future background to Monte Cook's *Numenera* pen-and-paper roleplaying game. This is an unrecognisable take on Earth one billion years in the future, with the accreted technological detritus of

innumerable vanished civilisations underpinning a mediaeval society bringing Clarke's third law to life. There's magic, but it's really science, spanning time travel, the transference of consciousness, parallel universes and nanomachinery.

You enter this world as the Last Castoff, coming to terms with your new identity as you plummet to your death like the doomed whale in *Hitchhiker's Guide*. You're an immortal creation of The Changing God, a futuristic sorcerer who transfers his consciousness into new bodies to unnaturally prolong his life.

His discarded former selves – the castoffs – form their own consciousnesses when they're abandoned. After death, you enter the Castoff's Labyrinth where your character's class and key traits are determined by a memory-probing personality test. After that, you awaken in the city of

Sagus Cliffs. Other castoffs are being hunted and finding a way to escape your fate motivates your first steps into the Ninth World. But quickly, the game becomes more about discovering this new world and the people in it, with your own story intertwining closely with what would be considered sidequests in other games. The term fits less well here because *Tides of Numenera* is cleverly designed to thread a diverse array of different plotlines together.

Your decisions really do matter. If you pick a trait like mind-reading, you can trust that this'll be incorporated throughout the campaign.

The pace of the game does struggle a little during its initial hours, particularly if the setting is new to you. By the time the plot really kicks into gear, you'll have all the knowledge you need.

This isn't your RPG if you want to spend lots of time thinking about item stats and party strategy. Instead,

a relatively simple skill system dictates how you use might, speed and intellect points to achieve your character's goals. Succeeding at a task works the same way whether you're having a conversation in the open world or fighting a battle. During encounters, the game becomes turn-based and combat-specific abilities can be used: but your regular skillset is still there, and if you want to solve a 'fight' by talking or hiding or rewiring an ancient device then you have that option.

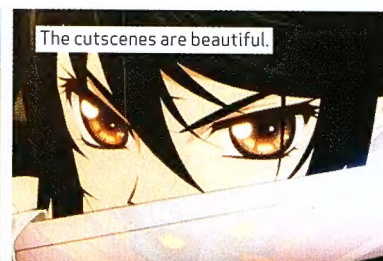
Torment is a game for readers, an adventure for people who don't necessarily want to fight – but it's great to have it back.

■ Chris Thursten

Verdict

Tides of Numenera is a thought-provoking adventure in a remarkable setting.





PC, PS3, PS4 | PS3/4, \$99.95; PC, US\$49.95 | WWW.BANDAINAMCOENT.COM

Tales of Berseria

Not quite as smooth as velvet.

A distant prequel to *Tales of Zestiria* and the 16th *Tales* game from Bandai Namco, *Berseria* is set in a complicated world. The lore of the Holy Midgand Empire is woven heavily into the story and dialogue, meaning it's often hard to keep up with what everything means.

We were excited by the idea that the game would explore the concept of 'Who are the real demons?' as you play as one, but we felt that this avenue was sadly overshadowed by the complicated lore and quirky characters. Despite the fact that Velvet is a sidestep in terms of *Tales* protagonists – driven on by revenge and apathetic to everything else – her companions are still fairly familiar.

When you escape from the demon prison in the early hours of the game, you have the option of talking to your fellow daemon inmates, revealing them to be as deep

and complex as humans themselves, despite some of them being zombies and werewolves. This led us to wonder many times why we were forced into battle with daemons on a regular basis.

The combat system has been tweaked slightly from previous outings, although it still heavily relies on memorising combos, which you can customise yourself through the complicated button allocation menus. It can be quite hard to remember where you're up to with combos, however, especially when switching between one foe and another. Weaving in Artes (magical attacks, mostly) adds another element of depth to the system, enabling you to stun or cause lasting ailments to your enemies before hitting them with more combos in a whirl of colourful motion blurs that's quite mesmerising when your whole team's at it. Newcomers to this series may find themselves

overwhelmed with the combat system, however.

We certainly were when we attempted to play this game with a mouse and keyboard (not recommended). Using a Steam Controller vastly improved the experience – but even then, we still found ourselves button mashing from time to time.

As always, the animation cutscenes (care of ufotable) are a real draw card for this series: they're absolutely stunning and provide a glimmer of modern style in an otherwise older-generation-looking game. We do have to mention that a bit of work needs to go into the English translation, as a lot of the dialogue sounded strange and some of the voice actors' deliveries were cringe-worthy (we're looking at you, Katz things). We also have to mention that the sound design grated on us for much of the game – for example, the sound of Velvet's feet on grass, stone and wood sounded like

variations of sandpaper. Luckily, the music is suitably quirky, dark, mystical and frantic, and does its best to drown out the annoying 'krrk krrk krrk' of Velvet's metal boots.

Although this game makes a few steps forward in terms of the maturity of its themes and of Velvet herself, it's still stagnating somewhat in terms of design. With a cleaner menu system, more populated and diverse landscapes and, to be honest, less fanboy-catering clothing, this game could have been a confident deviation to the norm.

Fans of the series will enjoy this; newcomers might be a little overwhelmed, however. **Carmel Sealey**

Verdict

Points for innovation, but it feels as though this game is dragging its heels in other places.





Big bada-boom

In ultimate irony, Samsung's battery factory explodes into flames.

Early in February, when consumers had not quite forgotten about the exploding Samsung Galaxy Note 7 phones, a "minor fire" broke out at a battery supply factory in China. While it hasn't yet been confirmed that the cause of the fire — faulty batteries, funnily enough — had any connection to the Note 7 problems, it's safe to say that this is just yet another kick to Samsung's groin of late. The company's reputation has taken a hit, according to the latest Harris Poll, dropping from 7th position to 49th in global company reputation ratings. What a bomb.



Say "Narcissism!"

STUDY FINDS EVERYONE HATES LOOKING AT YOUR SELFIES

Two researchers from Munich have conducted a study to figure out whether or not we like looking at each other's selfies. Spoilers: we don't. After being shown each other's selfies, 90% of case study volunteers said that they thought the pictures of others were self-promoting; however, only 46% of them said the same of their own pictures, which they claimed were more "authentic" or "ironic". Despite this apparent bias towards their own snaps, many of the participants agreed that selfies may result in negative self-esteem. Now, excuse me while I apply this beauty filter to my face because I can't stand the sight of regular me.



Taste the hacking

UNIVERSITY GETS DDOSED BY THE COKE MACHINE.

The Internet of Things feels as though it's being equal parts useful and dangerous recently, what with all the DDoS attacks being reported — the latest of which involves a university that experienced internet dropouts. After looking into the problem, it was discovered that the culprits were, lo and behold, soft drink machines and 5,000 other infected IoT devices, including light bulbs. According to a member of security, the botnet "spread from device to device by brute-forcing default and weak passwords". (How many times...?)



Jetzt zerstöre diese Puppe!

GERMAN PARENTS WARNED THAT CHILD'S TOY IS AN "ILLEGAL ESPIONAGE APPARATUS".

We've spoken about My Friend Cayla before in this mag (issue 437, p8 and 438, p12), but rather than a warning along the lines of "You probably shouldn't buy this", German parents are now being told to destroy Cayla by the country's Federal Network Agency. The doll has been classified as an "illegal espionage apparatus" and shops that continue to stock the toy will face fines. IoT-connected Cayla, who suffers from a lack of password, is apparently vulnerable to hackers up to 15m away, giving them the opportunity to listen in directly to the child playing with the toy. There's more than a snake in your boot, Cayla... There's a full-blown creepy stranger with a computer and a mic. ■

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- Smart Monitor Traffic Analyzer (up to 500 nodes)

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- High Availability Mode
- Object-oriented Firewall with Content Security Management (CSM) and QoS
- IPv6 x IPv4
- 1 x USB port (USB2.0) support file sharing, external storage, network printer or thermometer
- Central AP Management
- Central Switch Management
- Support VigorACS SI management system
- Smart Monitor Traffic Analyzer (up to 100 nodes)